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BUSBY (R FRANK) ASSOCIATES ARLINGTON VA
REVIEW OF MANNED SUBMERSIBLES DESIGN, OPERATIONS, SAFETY AND IN--ETC(U)
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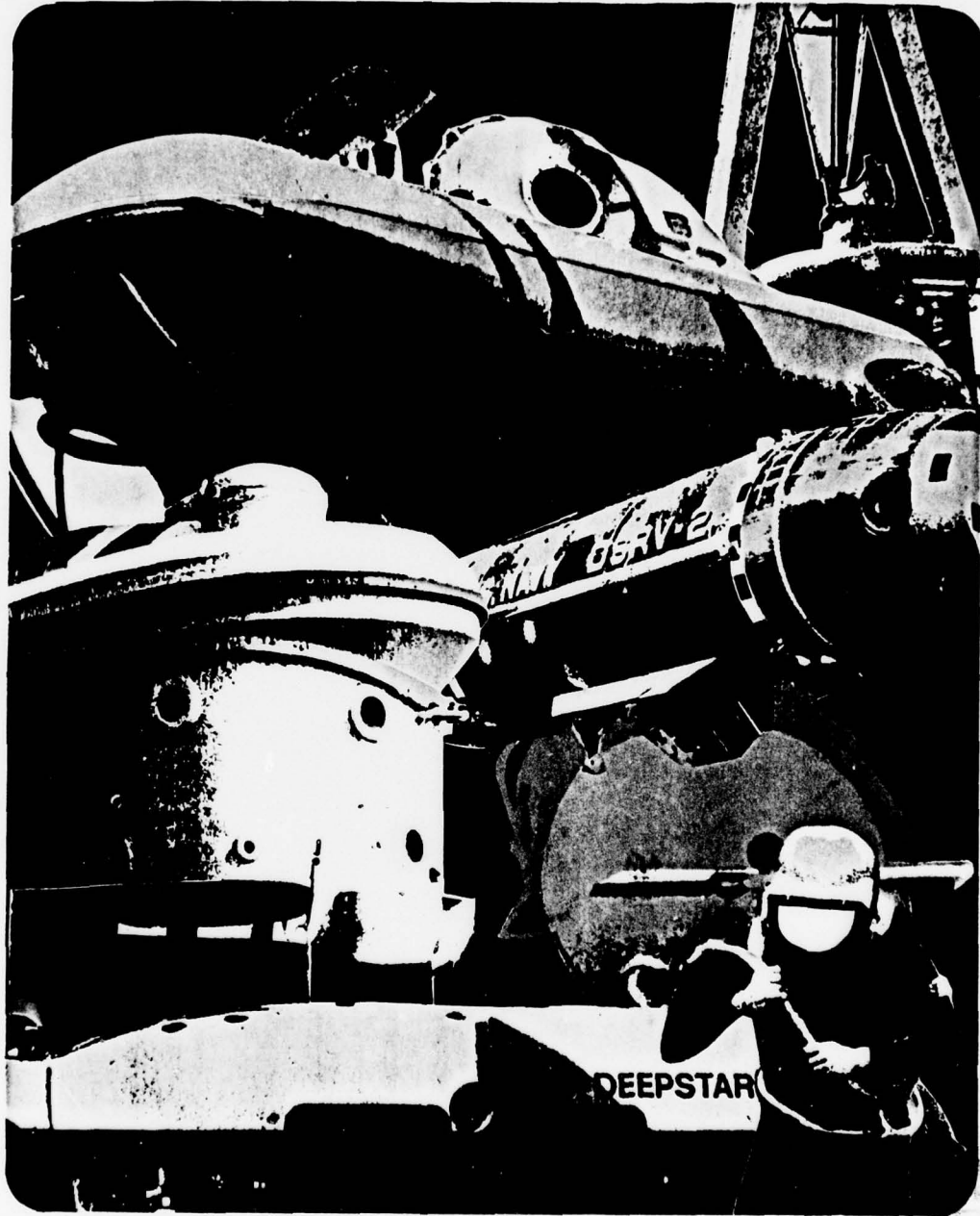
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REVIEW OF MANNED SUBMERSIBLES DESIGN, OPERATIONS, SAFETY & INSTRUMENTATION

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 MANNED UNDERSEA SCIENCE & TECHNOLOGY OFFICE

CONDUCTED BY: R. FRANK BUSBY ASSOCIATES, ARLINGTON, VA.
 UNDER CONTRACT N68463-77-C-0085

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DESIGN, OPERATIONS, SAFETY AND INSTRUMENTATION.

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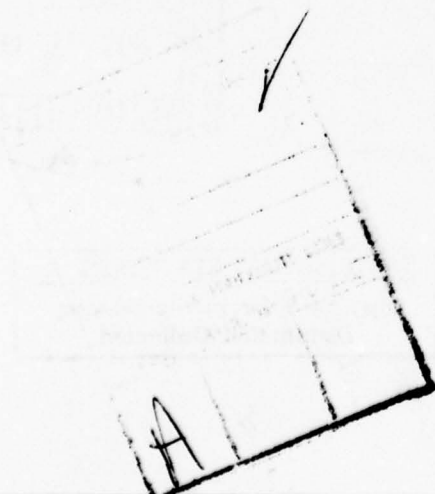
PREFACE

This report is an update of a U.S. Navy and U.S. Coast Guard inventory of worldwide manned and remotely operated vehicles which was published in September 1976. A third activity, the Manned Undersea Science and Technology Office of NOAA, joined in the funding of the update. The objectives of this study are: 1) obtain a complete description of presently operating submersibles in terms of dimensions, life support and emergency instrumentation; 2) define the scope of methods used to support, deploy and navigate the various vehicles; 3) tabulate and describe the international unmanned search/retrieval assets available in the event of an emergency; and 4) obtain a general overview of worldwide submersible activities.

The impetus for this study stems from a Federal interagency agreement referred to as the National Search and Rescue Plan (SAR), wherein the Coast Guard, who is responsible for search and rescue of civilian submersibles, may request assistance from the U.S. Navy in the event of a submersible emergency. Recognizing the vehicle-to-vehicle variation in design, instrumentation and capabilities, and the unprecedented surge in submersible activities since 1973, the three supporting activities sought to define the specific nature of these potential rescues and formulate a practical rescue scenario. While the major submersible activities are now in the North Sea offshore oil and gas fields, waters under U.S. jurisdiction could soon become potential areas for submersible activities equal to that of the North Sea. For this reason, and to maintain a current knowledge of submersible safety/emergency procedures, this study was undertaken.

In the first report all data were obtained by personally visiting and conferring with the builders and operators of operating submersibles. In this report all updates were obtained by written correspondence. Personal visits, where feasible, were made to inspect vehicles constructed during the period September 1976 through March 1978. Two ground rules governed the scope of this study: 1) only active submersibles and those under construction with operating depths of at least 1,000 feet (305m) were investigated; 2) no government-classified or company-proprietary data was solicited.

In only one instance did a member of the submersible community fail to respond to the update efforts. Other than this case, the response and cooperation by the submersible and remotely operated vehicle community was superb and is a practical demonstration of the community's sincere desire to participate in any program that might contribute to the safety of their diving personnel.





OCEANOGRAPHER OF THE NAVY
HOFFMAN II
200 STOVALL STREET
ALEXANDRIA, VA. 22332

29 September 1978

Subj: Survey of Operating Manned and Unmanned Submersibles;
distribution of

Encl: (1) Report, "Review of Manned Submersibles; Design,
Operation, Safety and Instrumentation," R. Frank
Busby Associates

1. A review of manned and unmanned submersibles, presently operating worldwide, was recently completed for the Oceanographer of the Navy, the National Oceanic and Atmospheric Administration, and the U.S. Coast Guard. The review emphasized those characteristics of the various submersibles which would be of high interest in rescue situations. In most instances, data were obtained by correspondence and discussions with the owners and operators of the submersibles.

2. The data were analyzed to obtain a complete description of the vehicle in terms of dimensions, life support, and emergency instrumentation. Further analyses were made to define methods of support, deployment, and navigation. International search/retrieval assets were assessed and a general overview of worldwide submersibles' activity was obtained.

3. Enclosure (1) is a report of this endeavor and is forwarded for your retention and utilization.



J. EDWARD SNYDER, JR.
Rear Admiral, U.S. Navy

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1.0 SUMMARY

1.1 GENERAL

There are 88 (56 in 1976) international manned submersibles now in operation or undergoing sea trials (Table 1.1). An additional 17 (22 in 1976) are being refitted or constructed which will be operational by the end of 1978. The focus of virtually all industrial activity is in European waters, particularly the North Sea. Industrial submersible operations in U.S. waters are negligible compared to Europe. The most active U.S. operators are the military and the academic community.

All major industrial or academic submersible builders and users comply with one of the following submersible classifying activities: American Bureau of Shipping, Lloyds Register, Germanischer Lloyds, Japan Ministry of Transport, or RINA (the Italian classification society). Military submersible builders design and construct their vehicles in accordance with their own certification criteria.

There are no national or international laws governing the construction or operations of manned submersibles other than minimal U.S. Coast Guard requirements for U.S. submersibles and Canadian Ministry of Transport regulations covering the AUGUSTE PICCARD.

One death occurred on 30 June 1976 which was submersible related. This brings the total fatalities to nine people in the 30 years of contemporary submersible development. Six were occupants of a submersible, three were involved in the support system.

The major employer of industrial submersibles is the offshore oil and gas community. Submersible work is primarily concerned with visual inspection and photographic/television documentation of pipelines and hardware, diver lockout support and simple manipulative tasks. Other industrial tasks involve a wide variety of location, retrieval tasks and debris clearance. Present submersible design and instrument developments are aimed at deeper, more specialized and more complex support of the offshore oil/gas customer. One atmosphere diving bells and diving suits have begun to impact on more conventional vehicles. The design of submersibles continues to be non-uniform and their equipments non-standard. Modifications to the vehicles are frequent and, consequently, descriptions of individual vehicles must be confirmed frequently and with the operator for accuracy. The location (i.e., home port) of individual vehicles depends upon the location of the job. It is not unusual for submersibles to operate off one country in one month and another country several thousand miles distant the following month. The dynamics of this industry, therefore, create great difficulties in deriving a typical rescue scenario or recommendations for standard emergency equipments/procedures.

1.2 OPERATIONAL PROCEDURES

1.2.1 Launch/Retrieval

The stern-mounted A-frame is the most widely used launch/retrieval configuration for rough water conditions today. Vickers Oceanics Ltd. states that operations

TABLE 1.1 MANNED SUBMERSIBLE SUMMARY

	<u>TOTAL VEHICLES</u>	<u>TOTAL OPERATIONAL/ SEA TRIALS</u>	<u>TOTAL INACTIVE¹</u>	<u>TOTAL UNDER CONSTR.</u>	<u>TOTAL REFIT</u>
USA	27	20	2	3	2
BRAZIL	1	1	0	0	0
CANADA	9	9	0	0	0
FRANCE	23	20	0	3	0
ITALY	2	1	0	0	1
JAPAN	3	1	1	1	0
NETHERLANDS	1	1	0	0	0
SWEDEN	1	1	0	0	0
SWITZERLAND	1	0	0	1	0
UNITED KINGDOM	32	25	0	7	0
USSR	9	8	1	0	0
WEST GERMANY	<u>2</u>	<u>0</u>	<u>0</u>	<u>2</u>	<u>0</u>
	112	88	4	17	3

1. Inactive: Has not operated since September 1976 Includes "unknowns."

can be conducted up to - and including - Sea State 6; the remaining operators place the limit into Sea State 5. Launching through a centerwell has been introduced as a means of deploying one-atmosphere bells.

1.2.2 Navigation (Submerged)

The most widely-applied, contemporary submerged navigation systems for commercial work are those utilizing a bottom-mounted transponder network. Submersible position accuracy, relative to a minimum three-transponder net, is advertised as ± 3 feet (0.9m). Ferranti Offshore Systems has introduced a High Accuracy Submersible Inertial Navigation System (HASINS) which was used in an Intersub submersible to provide position accuracies of ± 2 inch (5cm).

1.2.3 Life Support Duration

Life support duration ranges from approximately 14 hours/occupant (a fully loaded DSRV) to 305 hours/occupant (AUGUSTE PICCARD). The overall average duration is 90 hours/occupant; for North Sea operations it is 107 hours/occupant. Excluding the one-atmosphere diving suits, emergency food and water is carried by 77 percent of all vehicles; emergency clothing is carried by 28 percent.

1.3 SEARCH/LOCATION (SURFACE)

Six methods are used to locate submersibles on the surface: 1) by visually sighting either the sail or conning tower; 2) by visual sighting of flashing lights; 3) by detecting and obtaining a bearing on a radio signal (beacon) or interrogating a radio transponder; 4) radar reflection off the sail or a radar target; 5) by detecting and homing on a keel-mounted pinger (underwater telephone transducer) and 6) by visual sighting of pyrotechnics released by the submersible pilot.

1.3.1 Visual Sighting

All but five submersibles have a sail or conning tower (the one-atmosphere diving suits excluded). Under ideal conditions these can be seen out to an average 5.1 nautical miles (9.5km) from a height of 20 feet (6m). Eight vehicles have white colored sails. These are difficult to detect in the presence of white caps. For this reason most of the white colored vehicles have international orange or red conning towers.

1.3.2 Surface Lights

Seventy (70) percent carry flashing lights ranging in duration from 12 to 168 hours. The flash rate varies from vehicle-to-vehicle.

1.3.3 Radio Beacons

All but one vehicle carries a radio transceiver; five vehicles carry two. The range is estimated from 3 to 25 nautical miles (6 - 46km). Seventeen

vehicles carry radio beacons. Frequencies range from 2 to 243 MHz. Operating duration is from 12 to 120 hours. Two vehicles carry radio transponders.

1.3.4 Radar Reflectors

Eight vehicles are equipped with radar reflectors. The height above the water is from 2 to 6.5 feet (0.6 to 2m).

1.3.5 Surface Pingers

Less than 10 percent of all vehicles have a keel-mounted transducer or pinger.

1.3.6 Pyrotechnics

Rockets, flares, or smoke pots are carried by 18 submersibles. All but one store their pyrotechnics in the pressure hull. All, but seven, vehicles must open the hatch to activate the signal.

The best assurance the submersible has that it will be located when it surfaces is an accurate submerged tracking system aboard the support craft. Surfacing at night in Sea State 3 or greater would present a difficult, if not impossible, location problem for the majority of operators.

1.4 SEARCH/LOCATION (SUBMERGED)

Four major capabilities are available to the potential rescuer for locating a submersible that cannot surface: 1) surface location of an emergency marker buoy released by the submerged vehicle; 2) towed unmanned vehicles; 3) tethered, self-propelled, unmanned vehicles and 4) other manned submersibles.

In view of the average 3.75 days/crew member life support duration, the primary factor governing the success of these capabilities to provide timely assistance is the accuracy of the stricken vehicle's last known position. If the support ship cannot provide a location within ± 1 nautical mile (1.8km), then the search/location effort could take up a major portion of the life support available. When mobilization and transit time for the rescuer to reach the emergency scene is also subtracted, there is little time remaining to affect retrieval.

1.4.1 Marker Buoys

Forty two (42) percent of all submersibles have the capability for releasing an emergency marker buoy. The marker buoy, in all but two instances, is uninstrumented and can be only visually located. Consequently, the likelihood of locating the uninstrumented buoys at night is exceptionally small. Most buoys are small in size and visually locating them in daylight hours in greater than Sea State 2 would be difficult. If currents of 1 knot (1.8km/hr) or greater were running, it is speculative whether or not the positive buoyancy of most submersible buoys would allow them to remain afloat after they surfaced. The JOHNSON-SEA-LINK released a 20 inch (51cm) diameter sphere from 1,000 feet

(305m) depth in the approximate core of the Gulf Stream. The surface current was estimated at 3 to 4 knots (6 to 8km/hr). The buoy was tethered by a 0.2 inch (0.5cm) diameter line. The buoy surfaced and was soon dragged under by the current. This size buoy has a positive buoyancy of approximately 155 lbs (70kg). It was replaced with a 24 inch (61cm) diameter buoy. Tidally induced (periodic) currents of this magnitude can be found in many areas where submersibles now operate.

1.4.2 Towed, Vehicles

Ten devices which rely upon a surface ship for propulsion and provide a real-time (TV) viewing capability have been identified. Two of these can reach the operational depth of any presently operating submersible. Combining real-time viewing with long range acoustic search capability, these devices provide a means of location and identification of a submersible. Present towed devices, however, are limited in providing assistance within the average life support duration of submersibles; the limitations are: availability of suitably equipped support ships, and long mobilization time.

1.4.3 Remotely Operated Vehicles (ROV's)

Seventy four (74) self-propelled, tethered vehicles have been identified as operating or under construction throughout the world. This is an increase of 38 vehicles since September 1976 and does not include 120 PAP-104 vehicles which are used for mine neutralization. The greatest operating depth at present is 20,000 feet (6,096m); the average operating depth is approximately 3,231 feet (985m). All have TV, all provide excellent maneuvering capability and 40 percent provide a manipulative capability. The U.S. Navy's DEEP DRONE is maintained in constant readiness to perform military tasks and would assist in industrial submersible search/location.

The majority (79%) of these vehicles do not have a passive or active acoustic system by which they can home into visual (TV) range of a stricken submersible. Currents can create severe drag on the umbilical cable and thereby restrict these vehicles to limited searching range. The position, therefore, of the stricken vehicle must be precisely known if the majority of these vehicles are to realize their full search/location potential.

1.4.4 Manned Submersibles

The number of submersibles capable of coming to the aid of another submersible is first a function of depth. An examination of Table 3.1 reveals that the shallow diving submersibles (assuming they are not beyond crush depth) have a far larger inventory of potential locators than do their deep-diving counterparts. TRIESTE II can only be reached by the ROV RUWS. ALVIN, in view of TRIESTE II's extensive mobilization and transit time, is in the same situation.

While there is no legal requirement to do so, it is a general practice within the submersible community for an operator to ascertain the operational status and whereabouts of other submersibles - even though they may be competitors - so that some capability is available to assist in the event of

an emergency. This was amply demonstrated in the North Sea on 10 March 1978 when Intersub's PC-1202 freed P&O Subsea's PC-9 at 355 feet (108m) depth less than 24 hours after it was entangled.

Underwater visibility range, in the absence of ambient light and using artificial light, is rarely more than 30 to 40 feet (9 to 12m) using either a low light level TV or the human eye. Consequently, the searcher must have a means whereby he can direct his vehicle to within this range; this means is generally, if not always, by active or passive acoustic devices. Active acoustic devices are scanning sonars, CTFM sonars or conventional forward-oriented echo sounders. Eighty three (83) percent of the vehicles listed in Table 5.1 carry some form of active sonar which could be used for search/location. The greatest usable range of these sonars is 4,500 feet (1,372m).

Passive devices, those which can acquire an acoustic impulse and "home" to their source, consist of directional antenna (linear hydrophone array) and any of the CTFM or scanning sonars. The latter two devices are essentially limited to receiving a narrow band of frequencies. Thirty five percent of all submersibles carry a form of directional antenna. There is no standard receiving frequency; some receive between a range (25 to 40; 20 to 54 kHz), others receive two frequencies (10 and 27 kHz), while others receive only one frequency (27 or 50 kHz).

All submersibles carry an active acoustic source which can be used as a source to aid in its location. The most basic and universal of these devices is the underwater telephone, which all operating submersibles and those under construction carry. Other active acoustic devices are CTFM and scanning sonars (which have been discussed), pingers and transponders.

Underwater telephone frequencies vary, but 8 to 10 kHz is used by 80 percent of the current operators.

Pingers of various frequencies, repetition rate, and operating duration are carried by 75 percent of present submersibles. Frequency ranges are from 8 to 45 kHz. Approximately half of those in use transmit between 27 to 37 kHz.

Transponders are carried by 35 percent of the current vehicles. There are no two submersibles that use the same interrogate-respond frequency, except in instances where a company owns and operates more than one vehicle.

Under this "self-help" category, scanning sonars can also be included, since the submersible in extremis might acquire its searcher by the use of these instruments and "con" it to its location.

1.5 RETRIEVAL (LIFT POINTS)

There is only one general statement that summarizes the configuration, location and accessibility of lift point attachments whereby a line can be attached to lift any of the current submersibles to the surface: they all vary. The only exceptions to this statement are where more than one vehicle is operated

by the same company. Further complexity towards retrieval is introduced by vehicles which have no single lift point. In essence, each potential retrieval situation must be approached on a vehicle-to-vehicle basis, and no one retrieval hook configuration can be applied to all submersibles.

The means of attaching a retrieving line is afforded by one of three means: remotely operated vehicles, manned submersibles, and ambient-pressure divers.

Approximately 47 percent of the 75 operating and planned ROVs have some type of manipulative capability by which a line and hook can be attached. The deepest of those now operating is RUWS which can reach 20,000 feet (6,096m) in an emergency.

Approximately 87 percent of all submersibles have at least one manipulator; half of this number carries two. ALVIN, the deepest diving submersible which can realistically respond within the average life support duration of operating submersibles, can dive to - and beyond - the crush depth of any present submersible.

The greatest at-sea depth reached by an ambient pressure working diver, to date, is 1,510 feet (460m). Most commercial diving companies are working at maximum depths between 600 and 700 feet (183 and 213m) and average depths of 300 to 400 feet (91 to 122m). The mobilization time for most deep diving systems is 24 to 48 hours. Currents up to 3 knots (5.6km/hr) are considered the operating maximum. Sea State 6 is the approximate limit of operations, and at least a 2-point moor is required to station-keep. An additional time-consuming factor, relative to the manned and unmanned submersible, is involved in setting up the 2 to 4-point moor necessary to hold position. If the support ship is not moored directly over the submersible, additional time is required to adjust or, perhaps, completely relocate the moor. The diver's searching capability is limited to the water clarity unless hand-held active or passive sonars are made available; these are not standard diving system equipments. In view of the extensive application of ambient divers in offshore work it is probable that, at any given time, this capability would be ready to respond more quickly than the manned or remotely operated systems. The Harbor Branch Foundation, Ft. Pierce, Florida maintains a lockout submersible (JOHNSON-SEA-LINK I or II) in an operational (ready-to-go) condition at all times; no mooring is required to employ this system. The capabilities supplied by the lockout vehicle and diver seem best suited for rapid search/location/retrieval. The U.S. Navy maintains diving systems aboard the ASR's PIGEON and ORTELONE, one on the east coast and one on the west coast. These are in addition to numerous other readily-mobilized capabilities of lesser depth.

2.0 SUBMERSIBLE ACTIVITIES - WORLDWIDE OVERVIEW

Since 1973 the utilization of manned submersibles has mushroomed. More vehicles are now operating and under construction than at any other time. Where the customer of the 1960s was the Federal Government, it is now private industry; in particular, offshore oil and gas. A listing of worldwide submersibles is presented in Table 2.1.

TABLE 2.1 - CONTEMPORARY MANNED SUBMERSIBLES

<u>NAME</u>	<u>OPERATING DEPTH</u> <u>(ft/m)</u>	<u>BUILDER</u>	<u>OPERATOR</u>	<u>STATUS</u>
BRAZIL				
SUPERSUB 1**	984/300	Perry Sub. Bldrs. Riviera Beach, Fl.	Superpesa Transportes Maritimo Ltda, Rio da Janeiro	Operational
CANADA				
AQUARIUS I	1,100/335	HycO Vancouver, B.C.	HycO Subsea Vancouver, B.C.	Operational
AUGUSTE PICCARD	2,000/610	Giovanola Bros. Monthe, Switz.	Herton Maritime Exploration, Vancouver, B.C.	Operational
CONSTRUCTOR**	1,600/488	Deep Diving System Ltd, Thunder Bay, Ont.	Deep Diving System Ltd. Thunder Bay, Ont.	Operational
PISCES IV	6,600/2012	HycO	Dept. of Environment Victoria, B.C.	Operational
PISCES V	6,600/2012	HycO	HycO Subsea Inc. Houston, Tx.	Operational
PISCES VI	6,600/2012	Vancouver, B.C.	HycO Subsea Vancouver, B.C.	Operational
SEA OTTER	1,500/457	Anautics, Inc. San Diego, Ca.	Can-Dive Services, Ltd. Vancouver, B.C.	Operational
TAURUS*	2,000/610	HycO Vancouver, B.C.	Vickers Oceanic Ltd. Leith, Scotland	Construction
FRANCE				
CYANA	9,843/3,000	CEMA Marseille	CNEXO Toulon	Operational
GLOBULE	656/200	COMEX Marseille	COMEX Marseille	Operational

CONTEMPORARY MANNED SUBMERSIBLES (CONT)

<u>NAME</u>	<u>OPERATING DEPTH</u> <u>(ft/m)</u>	<u>BUILDER</u>	<u>OPERATOR</u>	<u>STATUS</u>
FRANCE (Cont.)				
GRIFFON	1,969/600	French Navy & Constr. Brest	French Navy	Operational
MOANA I, III	1,312/400	COMEX Marseille	COMEX	Operational
MOB 501**	1,640/500	COMEX Industries Marseille	COMEX Industries Marseille	Operational
MOB 1001** & 1002**	3,281/1000	COMEX Industries Marseille	COMEX Services	Operational
MOB 1003**	3,281/1000	COMEX Industries Marseille	COMEX Services	Operational
MOB 1004**	3,281/1000	COMEX Industries Marseille	N/A	Construction
NEREE***	656/200	COMEX Industries Marseille	Les Ressources Sous Marin Marseille	Operational
PC-8B	800/244	Perry Sub. Bldrs. Riviera Beach, Fl.	Intersub Marseille	Operational
PC-1201	1,000/305	Perry Sub. Bldrs. Riviera Beach, Fl.	Intersub Marseille	Operational
PC-1202*	1,000/305	Perry Sub. Bldrs. Riviera Beach, Fl.	Intersub Marseille	Operational
PC-1203	1,000/305	Perry Sub. Bldrs. Riviera Beach, Fl.	Intersub Marseille	Operational
PC-1204, 1205	1,200/366	Perry Sub. Bldrs. Riviera Beach, Fl.	Intersub Marseille	Operational
PC-16*	3,000/914	Perry Sub. Bldrs. Riviera Beach, Fl.	Intersub Marseille	Operational
PC-1801*, 1802*, 1804*	1,000/305	Perry Sub. Bldrs. Riviera Beach, Fl.	Intersub Marseille	Operational

CONTEMPORARY MANNED SUBMERSIBLES (CONT)

<u>NAME</u>	<u>OPERATING DEPTH</u> (ft/m)	<u>BUILDER</u>	<u>OPERATOR</u>	<u>STATUS</u>
FRANCE (Cont.)				
SHELF DIVER*	800/244	Perry Sub. Bldrs. Riviera Beach, Fl.	French Navy Toulon	Operational
S.M.I.*	984/300	French Navy & Constr. Yard Toulon	French Navy Toulon	Construction
ITALY				
PC5-C	1,200/366	Perry Sub. Bldrs. Riviera Beach, Fl.	Sub Sea Oil Services Milan	Refit
PS-2	1,025/312	Perry Sub. Bldrs. Riviera Beach, Fl.	Sub Sea Oil Services Milan	Operational
JAPAN				
HAKUYO	984/300	Kawasaki Heavy Ind. Kobe	Ocean Systems Japan Tokyo	Operational
TANKAI	656/200	Nippon Kokan K.K. Tokyo	Fuyo Ocean Dev. Co. Tokyo	Inactive
DSV-2K	6,562/2,000	Japan Mar. Sci. & Tech. Ctr., Yokusuka	Japan Mar. Sci. & Tech. Ctr. Yokusuka	Construction
NETHERLANDS				
SKADOC 1000	1,000/330	Skadoc Submersible Sys. Yerseke	Skadoc Submersible Sys. Yerseke	Operational

CONTEMPORARY MANNED SUBMERSIBLES (CONT)

<u>NAME</u>	<u>OPERATING DEPTH</u> <u>(ft/m)</u>	<u>BUILDER</u>	<u>OPERATOR</u>	<u>STATUS</u>
SWEDEN				
URF	1,509/460	Kockums	Royal Swedish Navy	Sea Trials
SWITZERLAND				
PX-28	1,640/500	Found. for Study and Protection of Seas and Lakes, Cully	Found. for Study and Protection of Seas and Lakes, Cully	Construction
UNITED KINGDOM				
JIM (12 ea.)***	1,500/457	Underwater Marine Equip. Ltd., Farnborough, Hants Hyco	Oceaneering Int. Sants Barbara, Ca. P&O Subsea	Construction (5 Units) Operational (7 Units)
LEO	2,000/610	Vancouver, B.C. Offshore Sub. Ltd.	Middlesbrough Offshore Submersible Ltd.	Construction
MANTIS**	2,000/610	Gt. Yarmouth	Gt. Yarmouth	Construction
MERMAID III* & IV*	853/260	Braker-Physik AG Karlsruhe, W. Germ.	P&O Subsea Middlesbrough	Construction Operational
PISCES II	2,400/732	Hyco	Vickers Oceanics Ltd. Leith, Scotland	Operational
PISCES III	3,000/914	Hyco	Vickers Oceanics Leith, Scotland	Operational
PISCES VIII & X	3,281/1000	Vancouver, B.C. Vickers Oceanic Ltd. Leith, Scotland	Vickers Oceanics Leith, Scotland Vicker Oceanics Ltd. Leith, Scotland	Operational Operational
T-1	3,000/914	Perry Sub. Bldrs. Riviera Beach, Fl.	Vickers Oceanics, Ltd. Leith, Scotland	Operational
VOL-LI*	1,200/366			Operational

CONTEMPORARY MANNED SUBMERSIBLES (CONT.)

<u>NAME</u>	<u>OPERATING DEPTH</u> <u>(ft/m)</u>	<u>BUILDER</u>	<u>OPERATOR</u>	<u>STATUS</u>
UNITED KINGDOM (Cont.)				
VOL-L2, L3, L4*, L5*	1,200/366	Vickers Oceanics Ltd. Leith, Scotland	Vickers Oceanics, Ltd Leith, Scotland	Operational
WASP***	2,000/610	Offshore Sub. Ltd. Gt. Yarmouth	Offshore Sub. Ltd. Gt. Yarmouth	Operational
UNITED STATES				
ALVIN	12,000/3,658	Litton Ind.	WHOI	Operational
ARMS**	3,000/914	Minneapolis, Minn. Perry Sub. Bldrs.	Woods Hole, Ma. Oceaneering Int.	Operational
ASHERAH	600/182	Riviera Beach, Fl. General Dynamics Corp. Groton, Conn.	Santa Barbara, Ca. New England Ocean Services Boston, Ma.	Operational
BEAVER*	2,700/823	North American Rockwell Seal Beach, Ca.	Int. Underwater Contr. City Island, N.Y.	Refit
DEEP QUEST	8,000/2,438	Lockheed Missile & Space Sunnyvale, Ca.	Lockheed Ocean Lab. San Diego, Ca.	Refit
DIAPHUS	1,200/366	Perry Sub. Bldrs. Riviera Beach, Fl.	Martech Int. Houston, Texas	Operational
JOHNSON-SEA- LINK I* & II*	3,000/914	Harbor Branch Found. Ft. Pierce, Fl.	Harbor Branch Found. Ft. Pierce, Fl.	Operational
JOHNSON-SEA- LINK III	2,500/762	Harbor Branch Found. Ft. Pierce, Fl.	Harbor Branch Found. Ft. Pierce, Fl.	Operational
MARFAB	N/A	MARFAB INC. Santa Ana, Ca.	MARFAB INC. Santa Ana, Ca.	Construction
MERMAID II	1,200/366	Bruker-Physik AG Karlsruhe, W. Ger.	Int. Underwater Contr. City Island, N.Y.	Construction Operational

CONTEMPORARY MANNED SUBMERSIBLES (CONT.)

<u>NAME</u>	<u>OPERATING DEPTH</u> <u>(ft/m)</u>	<u>BUILDER</u>	<u>OPERATOR</u>	<u>STATUS</u>
UNITED STATES (Continued)				
MYSTIC & AVALON	5,000/1524	Lockheed Missile & Space Sunnyvale, Ca.	U. S. Navy San Diego, Ca.	Operational
NEXTON A, B & C	1,000/305	General Oceanographics San Diego, Ca	General Oceanographics San Diego, Ca.	Operational
NR-1	N/A	General Dynamics Groton, Cn.	U. S. Navy	Operational
OPSUB**	1,000/305	Ferry Sub. Bldrs. Riviera Beach, Fl.	Ocean Systems Houston, Tx.	Operational
PC-14C-2	600/183	Perry Sub. Bldrs. Riviera Beach, Fl.	Kentron, Hawaii Huntsville, Ala.	Operational
PIONEER I	1,200/366	Martech International Houston, Tx.	Seahawk Oceanics Arlington, Tx.	Construction
SEA CLIFF	6,500/1,981	General Dynamics Groton, Cn.	U. S. Navy San Diego, Ca	Operational
SEA EXPLORER	600/183	Sea-Line, Inc. Brier, Wa.	Sea-Line, Inc. Brier, Wa.	Inactive
SEA RANGER	600/183	Verne Engineering Inc. Fraser, Mich.	Verne Engineering Inc. Fraser, Mich.	Inactive
SNOOPER	1,000/305	Undersea Graphics, Inc. Torrance, Ca.	Undersea Graphics, Inc. Torrance, Ca.	Operational
STAR II	1,200/366	General Dynamics Groton, Cn.	Deepwater Explorations, Ltd. Honolulu, Ha.	Operational
TRIESTE II	20,000/6,096	U. S. Navy	U. S. Navy	Operational
TURTLE	6,500/1,981	General Dynamics Groton, Cn.	San Diego, Ca. U. S. Navy San Diego, Ca	Operational

CONTEMPORARY MANNED SUBMERSIBLES (CONT.)

<u>NAME</u>	<u>OPERATING DEPTH</u> <u>(ft/m)</u>	<u>BUILDER</u>	<u>OPERATOR</u>	<u>STATUS</u>
<u>USSR</u>				
ARGUS	1,969/600	Institute of Oceanology Moscow	Institute of Oceanology, Gelundzhik	Operational
ATLANTA**	328/100	Giprorybflot Inst. Leningrad	Atlantic Research Inst. of Fisheries, Kaliningrad	Operational
OSA-3	1,969/600	Giprorybflot Inst. Ministry of Fisheries	Ministry of Fisheries Moscow	Operational
PISCES VII & XI	6,600/2,012	Hycro Vancouver, B.C.	Institute of Oceanology Gelundzhik	Operational
SEVER 2	6,562/2,000	Ministry of Shipping Industries of the USSR	Ministry of Fisheries Moscow	Inactive
TETIS**	656/200	Ministry of Shipping Industries of the USSR	Ministry of Fisheries Moscow	Operating
TINRO 2	1,312/400	Ministry of Shipping Industries of the USSR	Central Res. Inst. of Fish - Moscow	Operating
<u>WEST GERMANY</u>				
MERMAID IV* & V*	984/300	Bruker-Physik AG Karlsruhe, W. Ger.	Bruker-Physik AG Karlsruhe, W. Ger.	Construction

* Lockout
 ** Tethered
 *** One-man vehicle
 **** Tethered, one-atmospheric bell

The classifications used in this table are defined as follows:

Operational: The submersible has operated at least once within the period September 1976 through June 1978, and submersibles that can be ready within 48 hours to dive which have a trained, operational crew available.

Sea Trials: Submersibles that have recently been constructed or refitted and are conducting test and evaluation, and/or crew training dives.

Refit: This term includes vehicles which are undergoing or will undergo major modifications.

Construction: Vehicles being constructed.

Inactive: Vehicles which have not dived since September 1976, but could dive on short notice.

Twenty vehicles which appeared in the September 1976 listing have been omitted, owing to various reasons, from Table 2.1. The vehicles omitted are listed in Appendix II. The operators of STAR II were not responsive to inquiries regarding their vehicle's activities, but it is reportedly operational. Several vehicles (e.g., PIONEER I, PX-28, MERMAID V & VI) are in such incipient stages of construction that details are not available which would be helpful to this study. In such instances the vehicles may only be listed in Table 2.1 and not have a specification sheet in Section 3.0. Data on Soviet vehicles not operated by the Institute of Oceanology was obtained from personnel of that Institute. It was not feasible to confer with Ministry of Fisheries personnel at the time of the Soviet Union visit (Dec. 1975).

2.1 Construction

Canada and the United States are dominant in submersible construction. The major producers are International Hydrodynamics, Ltd. (Hyco) of Vancouver, B.C. and Perry Submarine Builders of Riviera Beach, Florida. The former has produced 14 units, the latter 25.

Since the last reporting period several European and British firms have become more dominant in construction: COMEX Industries, Vickers-Slingsby, Underwater Marine Equipment Ltd. (UMELS), Offshore Systems Engineering Ltd. (OSEL Group) and Bruker-Physik AG.

COMEX began construction of submersibles in 1972 with NEREE. Since then they have produced GLOBULE (1973), MOANA I (1974), MOANA III (1976), MOB 501 (1976), MOB 1001 & 1002 (1977), and are presently constructing MOB 1003 & 1004. COMEX and Kockums shipyard (Malmo, Sweden) collaborated to produce the URF, a rescue submersible designed for the Royal Swedish Navy. The MOB (Manipulation Observation Bell) series of vehicles are essentially, tethered, one-atmosphere diving bells with propulsion for limited maneuvering at the work site and manipulation for conducting repair/maintenance-type work.

Vickers-Slingsby has produced two of the LR-class vehicles (conventional, one-atmosphere submersibles), two of the LR-class DLO submersibles (diver lockout) and one T-class (increased endurance, compact size). A second T-class vehicle is reportedly under construction. Vickers-Slingsby has also designed a one-atmosphere diving suit called OMAS, at this writing it has not been confirmed that the OMAS system is actually under construction. The LR-class vehicles are the only operating submersibles known to employ pressure hulls made from glass reinforced plastic (GRP). Vickers has also entered the ROV construction field with the advent of their tracked, bottom-crawling cable burial vehicle SEACAT. SEACAT receives its power through a surface umbilical, but is controlled by an attendant submersible, subsequent improvements are aimed at reducing the degree of reliance upon the submersible. Another underwater construction development is taking place at Vickers-Intertek involving subsea wellhead maintenance. Known as the Neutrabaric method, the hardware consists of two steel chambers which encapsulates a wellhead and is filled with water at one-atmosphere pressure. This allows the diver to work under shallow water conditions at ultimate depths of 1,968 feet (600m). Transfer to and from the wellhead is provided by a submersible, TAURUS A, which locks onto the system and permits the diver/technician to swim into the two chambers to carry out work on the wellhead.

Underwater Marine Equipment Ltd. has been producing JIM-type, one-atmosphere diving suits since 1973. At this point there are a total of 20 which have been produced or are under construction. A deeper version of JIM, called SAM, has been produced but is not yet operational. UMELS has also entered the ROV field with construction of the tethered, free-swimming SEASPY.

In 1977 OSEL Group completed construction of two, one-atmosphere, diving suits called WASP. The WASP design incorporates JIM-type arms and, instead of legs, propulsion units which are controlled by the pilot's feet and receives power through a surface umbilical. These first two units belong to Oceaneering International. Two one-man submersibles called MANTIS have also been produced by OSEL. MANTIS is a tethered vehicle with a glass hemi-head and versatile mechanical arms. The most unorthodox aspect of the MANTIS vehicles is their ability to function as ROV's when a human is not required. At this time (June 1978) no sales of MANTIS are known to have been consummated.

The West German firm Bruker-Physik AG has begun construction on MERMAID V and VI. Both are lockout vehicles which are essentially of conventional design. The VI vehicles is designed to function as diver lockout, dry transfer and submarine rescue. These two vehicles make a total of five (one one-atmosphere and four dive lockout) that Brucker-Physik will have produced.

U.S. submersible construction activities are momentarily less dynamic than is evident in Europe. Perry Submarine Builders delivered the lockout vehicle SUPERSUB I to a Brazilian firm in January 1978. SUPERSUB I is unique, in that it has lead acid batteries and can also be powered from the surface through an umbilical. When not required, the umbilical cable can be detached to permit the vehicle to operate as a conventional, self-powered submersible.

2.2 Operational Activity

2.2.1 Japan¹

One submersible is presently operating in Japan: HAKUYO. SHINKAI, owned by the Japan Maritime Safety Agency, was retired in January 1977. HAKUYO, operated by Ocean Systems Japan, Ltd., is active in commercial projects which include bottom surveys for pipelines and cables, bridge construction and other survey/sampling tasks involving undersea engineering.

Mitsubishi Heavy Industries is constructing a 2,000m (6,562 ft), one-atmosphere submersible for the Japanese Marine Science and Technology Center (JAMSTEC), at Yokosuka. The vehicle is tentatively designated as DSV-2K and will be used for scientific research and study when completed in 1981.

The tethered vehicle UZUSHIO has been scrapped and will be replaced by a new vehicle designated TANKAI. The principal characteristics of TANKAI will be similar to UZUSHIO. TANKAI will be launched in June 1978 and delivered in September 1978.

The Japanese Navy's experimental rescue submarine CHIHIRO has finished her duties as a test platform for evaluation of various equipment developments and is now on permanent exhibition for educational purposes.

JAMSTEC habitat SEATOPIA has not been employed since 1975. Instead, ambient-pressure diving has been conducted in a simulator; 200m (656 ft) depth was made in 1977 and 300m (984 ft) will be attempted in 1978.

2.2.2 Canada

Canadian activities are more operational than constructional. An affiliate of Hyco, Hyco Subsea Inc., based in Houston, Texas, has three operational submersibles under its control: AQUARIUS I, PISCES V and VI. AQUARIUS I has been actively involved in offshore oil work (see Table 2.2) in the Gulf of Mexico. PISCES V will begin work this summer in support of a drilling platform off the east coast of Canada. PISCES VI began a year long contract in the spring of 1978 for Getty Oil from aboard the drillship DISCOVERER SEVEN SEAS off South Africa. Between 16 to 29 October PISCES VI was employed by the U.S. Environmental Protection Agency. This work involved inspection of drums in which low level radioactive waste was disposed in 3,000 feet (914m) depth off the Farallon Islands.

AUGUSTE PICCARD, the worlds largest submersible, became operational in the fall of 1977. In the spring of 1978 the vehicle was engaged in acoustic surveying for pipelines and cables for the B.C. Hydro and Power Authority. A unique deployment of the ROV TREC was made by AUGUSTE PICCARD to demonstrate the submersibles capability to act as an underwater support platform for remotely operated vehicles.

¹Information on Japanese submersible activities was generously supplied by Dr. Akira Koriki, Director, Research and Development, JAMSTEC to whom we are grateful.

Deep Diving Systems Ltd. of Thunder Bay, Ontario launched the tethered, lockout vehicle DDS CONSTRUCTOR in the spring of 1978. Unlike other tethered vehicles, CONSTRUCTOR receives not only electrical power from the surface, but breathing gases and hot water as well.

The Canadian government vehicle PISCES IV (Dept. of the Environment) and SDL-1 (Canadian Armed Forces) have conducted a variety of scientific and military missions during the past two years.

TAURUS A, built by Hyco, was sent to England in the winter of 1978 where it is under charter to Vickers Oceanics.

2.2.3 United States

Military

The U.S. Navy operates six manned submersibles: SEA CLIFF, TURTLE, TRIESTE II, NR-1, MYSTIC and AVALON (the latter two were originally designated DSRV 1 & 2). NR-1's operations and capabilities are classified and, therefore, does not lend itself to this report.

SEA CLIFF and TURTLE, sister submersibles, have conducted small object location and recovery dives and scientific research. Other than its primary role of search/retrieval, SEA CLIFF was involved in geological research off Mexico in the fall and winter of 1977. TURTLE conducted geological investigations and bottom hardware inspection off the Hawaiian Islands in the summer of 1978. Both vehicles are to undergo modification and change of pressure hulls. TURTLE is to be upgraded to 10,000 feet (3,048m) by 1979. SEA CLIFF's pressure hull will be replaced with a titanium sphere and will have a 20,000 ft (6,096m) depth capability by 1981.

TRIESTE II operated in the Atlantic Ocean in the summer of 1977 conducting geological investigations at depths to 20,200 ft (6,157m). The bathyscaph is presently undergoing maintenance.

AVALON and MYSTIC were formally accepted into naval service on 10 December 1977. They will take part in "fly away" operations three times each year when they will be flown to one of seven Navy port areas in the U.S. for exercises. Otherwise, they will standby in the event of a submarine emergency.

Industrial and Academic

At the end of Fiscal Years 1976 and 1977 (30 September 1976 and 1977, respectively) Busby Associates conducted a survey and analysis of submersible operations conducted in U.S. waters for the Manned Undersea Science and Technology Office of NOAA. Data from the first of these reports was presented in the MUS&T Office's annual report for FY 1976. The following is a synopsis of the 1977 data and a comparison with 1976 operations.

In fiscal year 1977 civilian submersibles were utilized during a total of 676 dive days. These dive days represent a total of 899 dives. Groupings

of dive days per type of mission are shown in Figure 2.1. For comparison, FY 1976 dive day activities (498 dive days for 888 dives) are also shown in the same figure. In cases where a dive was listed for two purposes (geology and biology, for example) each mission category was increased by one half dive and one half dive day. Data used to prepare Figure 2.1 is detailed by submersible and mission category in Table 2.2.

An exact comparison between totals of dives and dive days from year to year could be misleading because each deep ocean dive generally requires one dive day while in shallow areas several dives could be made in a day. Thus the statistics are project-oriented and the important relationship between successive sets of annual data are those trends reflected by mission category statistics. Submersible utilization trends between FY 1976 and FY 1977 are illustrated by percentages of sets of mission categories as shown below:

Percent of Total Dive Days (Major Categories)

	FY 1976	FY 1977
Basic Research	54%	26%
Commercial Operations	27%	55%
Test and Training	15%	16%

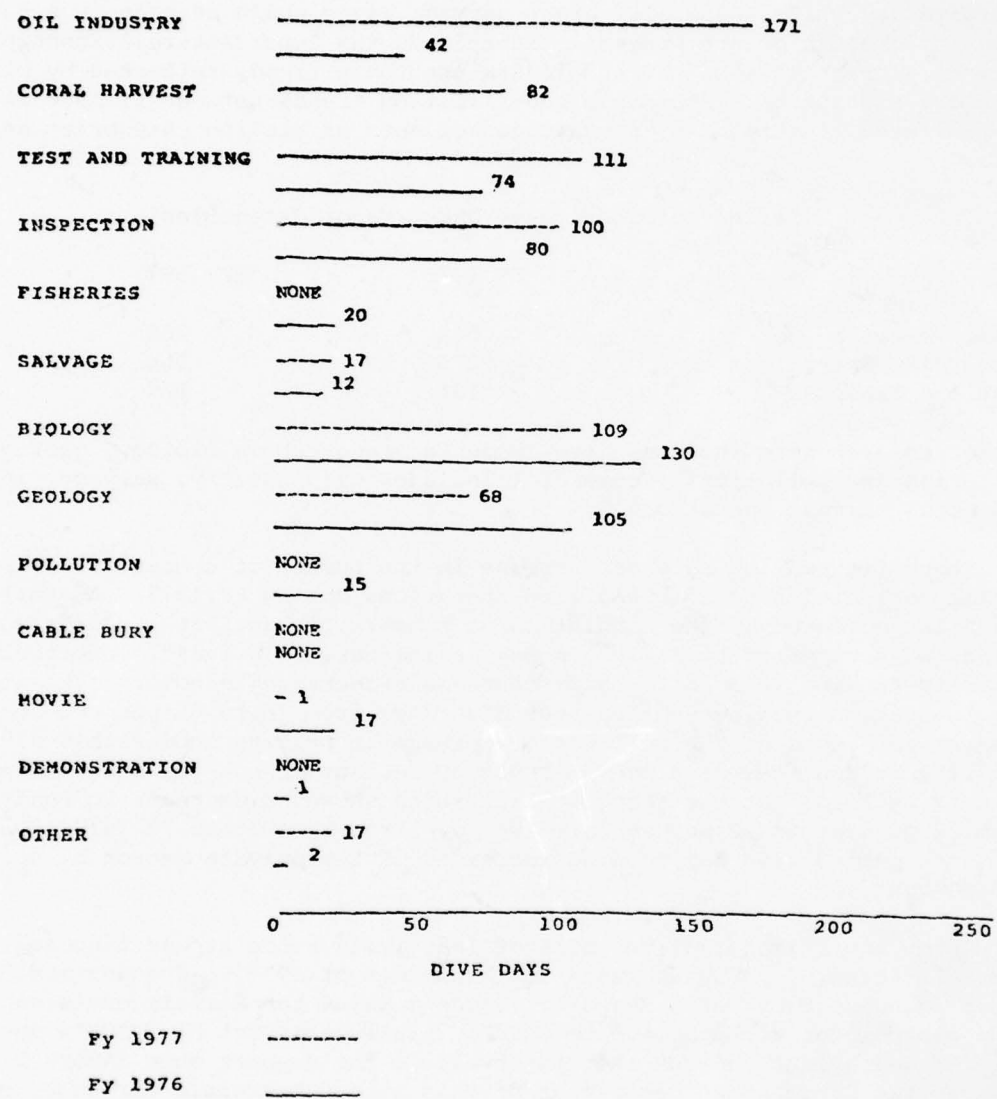
Basic Research here includes dives made for research in biology, geology, fisheries and pollution. Commercial includes oil industry, salvage, inspection and coral harvest operations.

These figures indicate an increase in the number of commercial or industrially oriented submersible diving operations during FY 1977. A similar trend is indicated by the tabulation of submersible activity funding sources which, when compared to FY 1976 shows an increase in private submersible activity funding from 28 to 55 percent and a decrease in government, academic and foundation funding sources (per dive day) from 76 to 45 percent during the period. Some of the percentage increase in private submersible diving activity is due to a decrease of about 30 percent in non-private funding. This is reflected at the federal level which showed a decrease in funding of from 32 percent to 22 percent of dive days from FY 1976 to FY 1977. During the same period dive day funding increased in the private sector by nearly 100 percent.

After approximately five years of inactivity since it was launched, Ocean System's tethered OPSUB was used in the summer of 1977 to conduct manipulative tasks in support of North Sea oil. Present plans tentatively envision addition of a manipulator work package to OPSUB. A unique aspect of OPSUB's operations was its deployment through the centerwell of the support ship SAMSON DIVER. This is the first known deployment of this type submersible through a centerwell.

Oceaneering International took delivery on the Perry-built, one-atmosphere vehicle ARMS in late 1976. ARMS (Atmospheric Roving Manipulator System) is similar in operational concept to the COMEX MOB vehicles. ARMS has not yet

MISSION CATEGORY



Civilian Submersible utilization in the United States, October 1976 to September 1977.

Figure 2.1

TABLE 2.2

U. S. CIVILIAN SUBMERSIBLE MISSION CATEGORIES
(OCTOBER 1, 1976 to SEPTEMBER 30, 1977)

Mission Category	ALVIN	AQUARIUS*	DEEP QUEST	DIAPHUS	JOHNSON-SEA-LINK I	JOHNSON-SEA-LINK II	MERMAID II	NEKTON ALPHA	NEKTON BETA	NEKTON GAMMA	NEOS I	PC-14-C-2	SEA EXPLORER	SNOOPER	STAR II	TARUS*	TOTALS	TOTAL PERCENTAGE OF DIVE ACTIVITIES	
Oil Industry		142 115					23 15	40 41									205 171	23 25	
Coral Harvest													82 82				82 82	9 12	
Test & Training	9 9		3 3		24 18	10 7	27 8	5 1	3 2		9 3						54 60	144 111	16 16
Inspection	6 4				28 17	20 14			5 2		12 5	38 35	62 23				171 100	19 15	
Fisheries																			
Salvage								38 17									38 17	4 3	
Biology	40 40			20 11	14 5	90 53											164 109	18 6	
Geology	62 61			14 7													76 68	8 10	
Pollution																			
Cable Bury																			
Movie													2 1				2 1	1 0	
Demonstration																			
Other					17 17												17 17	2 3	
Total Dives	117	142	3	34	66	120	44	28	46	40	21	38	0	64	87	54	899	100	
Total Dive Days	114	115	3	18	40	74	25	16	21	41	8	35	0	24	82	60	676	100	

*Canadian submersibles working in U.S. waters.

00	Dives (upper numbers)
00	Dive Days (lower numbers)

made a contractual dive. Present plans are for the vehicle to operate under contract from a drilling vessel off the east coast of Canada in the summer of 1978.

2.2.4 Europe and England

The overwhelming majority of commercially available submersibles are located in Europe. Most of the activity is concentrated in the North Sea, but the Mediterranean, Persian Gulf and the coast of Africa also provides submersible work. The major suppliers of submersible services are Vickers Oceanics Ltd. (10 submersibles), Intersub Ltd. (11 submersibles), COMEX Services (6 submersibles), P&O Subsea Ltd. (4 submersibles) and UMEL in conjunction with Oceaneering International (7 JIM suits and 2 WASPS).

The tasks conducted by European submersible operators and the development work underway to increase their present capabilities is varied. Virtually all work conducted by commercial operators is in support of offshore oil and natural gas. The following discussion highlights the activities of various companies under the categories of "activities" and "development".

Activities

The tasks listed below are those reported by the individual companies. This listing is not meant to be comprehensive, but only to indicate the type of work being performed and, when available, the customers. The majority of this data was obtained from Offshore Services, November 1977 (see Section 6.0) and it incorporates work by Vickers Oceanics, Intersub and P&O Subsea.

- Statoil: Norwegian Trench pipeline route survey. Equipment employed included high resolution echo sounder, side scan sonar, stereophotographic system, coring device doppler navigation system.
- Thistle Field: wellhead removals, checking ballast and cooling water inlets on concrete platforms, anchor recovery, wire and cable cutting, measurement of spool pieces for tie-in to platform risers.
- Union Oil, Heather/Ninian Pipeline: damage survey, debris recovery.
- Occidental, Piper: pipeline inspection, anchor/cable survey.
- Mogul, Beryl "A" platform: video survey.
- Oceanic Contractors, Heather: debris retrieval, wellhead/pipeline marking, wellhead recovery, jacket positioning.
- Ministry of Defense (Navy): submarine dry transfer trials and torpedo recovery.
- BP Petroleum Ltd., Forties pipeline: inspection.
- Shell Expro, Flags gasline: inspection.
- Hamilton Brothers Oil and Gas Ltd.,: anchor survey.
- Phillips Petroleum Co., Ekofish: pipeline survey, leak detection, sandbagging.
- Brown and Root, Stattjord: pipe laying support facilities.
- Chevron Petroleum (UK) Ltd., Ninian: burial trials.
- BNOG, Thistle platform: monitor of laydown head, pipeline repairs, debris survey/retrieval, pipeline survey, corrosion-potential monitoring, survey of slam lines.
- BNOG, Dunlin: spool piece survey.

- Siebens, Shetlands: wellhead demolitions.
- Shell, Brent: tie-in measurements, video surveys, post-bury survey, leak detection, flange surveys, contour surveys, anchor chain surveys, cable cutting, ultrasonic water/pig detection, pipe lay guidance, topographic survey.
- Italcable, Mediterranean: cable burial.
- Union Oil, Heather platform: diver lockout support.
- Construction and installation support and pipeline survey/inspection for: Flags gasline, Statfjord A platform, Ninian south platform, TCP2 platform, Dunlin A platform and the Statfjord field. Work involved in these contracts included cutting tow lines, inspection of anchor mounds, clearing blocks, debris clearance and inspection.
- Ekofisk-Teeside oil pipeline: automatic tracking and overburden measurements.
- Sofiran and OSCO, Kharg Island pipelines: cathodic potential measurements.
- Shell, British Petroleum, Mobil Oil: precise distance and orientation measurements using inertial navigation techniques (see Section 5.5.4).
- Chevron Oil, BEN OCEAN LANCER: diver lockout support.
- Shell, Flags line: sediment sampling and bearing strength measurements using a cone penetrometer.
- Amoco, Rough field: pipeline survey.
- Total, MCPO1 platform: video survey.
- Conoco, Murchison field: bottom surveys.

More specific information on individual submersible activities was supplied by COMEX and is synopsized below.

PC 1203 (aboard M/V PROTEE):

TOTAL FRIGG contract: In four months of contract, the submersible has surveyed 436km (272 miles) of pipe and has undertaken 120 dives for a total time of 623 hours. The average distance of survey was 5.45km (3.4 miles) per day. Launch has taken place in force 5 seas and recovery in up to force 6 seas on some occasions. Night dives have been regularly made.

ELF NORGE contract: Location of all man-made debris and large rocks on old well sites. An ELA array was moored by the ship on each area. Three sites have been surveyed in four dives for a total duration of 16 hours 33 minutes.

MOANA III (aboard EXPLORER):

Recovery of RCV 225 (North Sea): Recovery of remotely operated vehicle whose tether was entangled in other cables. Cutting three steel cables and one nylon rope permitted recovery of the ROV without damaging it or its tether. The cutting was done by hydraulic cutter, the operation lasted five hours.

SHELL contract (North Sea): Survey of abandoned drilling locations, and location of all debris in the area. An ELA array was moored by the ship

and calibrated by the submersible before each survey in order to obtain a high accuracy underwater navigation. Eleven sites have been surveyed in fifty dives for a total duration of 211 hours. The submersible was launched and recovered in winds of up to 20/25 knots and Sea State 5. Night dives have been regularly made.

FTP contract (North Sea): Survey of 800m (2,624 ft) of pipe at 325m (1,066 ft) depth. Complete video recording and still photography was conducted from the submersible. Using a special device fixed on the manipulating arm, determination was made if the pipe was empty or full of water. Four dives for a total time of 15 hours.

MOANA I (aboard barge ANGUILLE):

ELF GRODIN contract (Gabon): Assistance to lay barge, interventions on experimental underwater wellhead. In nine months, MOANA I completed 92 dives. The average dive time was 2 hours 53 minutes. The longest dive lasted 5 hours 30 minutes. The average diving conditions were good with little sea and wind and good bottom visibility.

GLOBULE - MARSEILLES:

Used for pilot training in Marseilles and now operational in the Persian Gulf.

MOB 501:

GETTY OIL contract (aboard DISCOVERER SEVEN SEAS, Guinea Gulf of Abidjan): Drilling assistance, installation of mandrel for U.X. ring, explosive placed on wellhead, recovery of transponders. Forty dives performed for a total duration of 112 hours.

MOB 1001 (aboard PELERIN):

CFP/TOTAL contract - Algeria: Recovered false base acoustic transponder (300kg with bracket). Dive performed at night at 920m (3,018 ft) depth, total duration three hours.

CFP/TOTAL contract - North Sea: Observation dive 120m (394 ft), Sea State 5 to 6.

CFP/TOTAL contract - Groenland: Drilling assistance, explosives placed in housing for plug abandon. Five dives performed, total diving time 12 hours.

CFP/TOTAL contract - Kenya: Presently operating with 2/3 knots current at 920m (3,018 ft) depth.

MOB 1002 (aboard DISCOVERER SEVEN SEAS):

GETTY contract - Red Sea - First location: Assist in spudding in, running surface casing, stack loading. Forty-three dives performed for a total diving time of 120 hours.

GETTY contract - Red Sea - Second location: Surface casing was guided into an open-hole in the sea-bed. The bell assisted in re-entry of bit. Three dives for one day on location, total diving time 5 hours.

TOM 300 (remotely operated vehicle):

Pechiney contract - Mediterranean Sea: Pipe survey with continuous video recording, search for debris close to the pipe, cathodic cables inspection and manipulation, trials of "Trakpipe system". Fourteen km (7.6nm) of pipe surveyed within two days, one dive of 9 hours providing a 11.5km (6.2nm) length inspected without surfacing from 20 to 210m (66 to 689 ft) depth.

Developments

Several areas of submersible work capabilities are currently being improved upon and other capabilities have been or are being developed. Since some portion of current developments are company-confidential, it is only possible to list those developments which have been publicized. Navigational and launch/retrieval developments are discussed in sections 5.4 and 5.5, respectively.

Nondestructive Testing: The establishment of English and Norwegian inspection programs/standards for offshore structures has created a market for underwater NDT. In most instances the submersible operators have responded by equipping diver lockout vehicles to conduct these tasks. Equipments now being deployed are generally off-the-shelf instruments packaged for underwater work. Development work is being conducted in the following areas to meet this new market:

- Corrosion-potential measurements
- Ultrasonic thickness measurements
- Ultrasonic flaw detection
- Acoustic Holographic flaw detection
- Magnetic particle inspection
- Magnetographic crack detection
- Eddy Current crack detection
- Sterephographic, detailed, color photography
- Three-dimensional enhancement of video tapes
- Concrete deterioration meters
- Concrete coring tools.

Related to these tasks are developments in underwater painting, stud welding, and epoxy patching. Also related are development of methods to lock the submersible onto the bracing of a steel platform in mid-water. Intersub has developed a method involving a self-winding metal strap for attaching to bracings from 20 in. (51cm) to 72 in. (183cm) diameter. A heavier alternative was tried which involved a mechanical hook housed behind the submersible conning tower. With bracings greater than 24 in. (61cm) diameter the hook became too cumbersome. Suction pads and "stickey feet" have also been tested, but with varying degrees of success.

Diver Lockout: Technique and equipment have been developed to extend the duration of lockout divers and to provide diver heating while minimizing electrical consumption. Vickers has progressed to the stage where, in 1976, divers logged 174 days of saturation in over 60 working dives from submersibles. About 90 percent of Vickers lockout work is at 470 to 500 feet (140 to 152m), the maximum depth to date has been 510 feet (155m). Intersub is developing a system for diver heating which relies on the heat-retaining properties of salt to heat water circulating within the diver's suit. The main advantage of the system is that the submersible is provided an extra energy source of 35 KW for only 132 pounds (60kg) of additional weight. The system has undergone a series of tests and was successfully used on a recent contract for Occidental.

Explosive Welding: Vickers Offshore, Ltd. has developed an explosive welding technique which produced acceptable (to Lloyds Register and Det Norske Veritas) welds on 16 in. (41cm) pipe in 400 feet (122m) depth in 1977. Eventually, the technique is aimed at producing acceptable welds on large and small diameter pipes in 1,500 feet (457m) depths. The welding process employs a shaped charge to fast-expand a section of pipe into the counter bore of a special sleeve forming a solid phase inter-molecular bond. The resulting weld is similar to that obtained by conventional fusion welding, but it is achieved more rapidly and offers a high degree of reliability and repeatability. Since the weld is achieved with virtually no melting, there is no heat-affected zone.

The above are only a few of the development projects now underway. European submersible operations are investing significant sums of money into these and other new products. Some idea of this expenditure is provided from Intersub Development's new product budget which was \$302,000 in 1976 and estimated to exceed \$1.5 million in 1977.

2.2.5 USSR

Submersible operations in the Soviet Union are conducted by the Ministry of Fisheries and the Institute of Oceanology. The Ministry of Fisheries' activities are directed towards biological studies, assays of foodstocks and evaluation of fishing techniques; they have several vehicles, of which OSA-3 is the latest. The Institute of Oceanology conducted an extensive scientific study of Baikal Lake in the summer of 1977 with PISCES VII and XI. In the fall of 1978 PISCES VII is scheduled to conduct orientation dives in the western Pacific from aboard the R/V DMITRY MENDELEEV. The primary goal of this expedition is to gain experience in operating a submersible in the open ocean from a large research vessel.

3.0 SUBMERSIBLE CHARACTERISTICS

The following pages contain dimensional, instrumentation and operational descriptions of submersibles now operating or under construction. For quick reference to submersibles of varying operational depths, Table 3.1 is included.

TABLE 3.1

MANNED SUBMERSIBLES IN ORDER
OF INCREASING OPERATING DEPTH

	<u>Feet/Meters</u>		<u>Feet/Meters</u>
*ASHERAH	600/183	URF	1509/460
PC-14C-2	600/183	CONSTRUCTOR	1600/488
*SEA EXPLORER	600/183	PX-28	1640/500
SEA RANGER	600/183	MOB 501	1640/500
GLOBULE	656/200	GRIFFON	1969/600
NEREE	656/200	*OSA-3	1969/600
*TANKAI	656/200	ARGUS	1969/600
*TETIS	656/200	MERMAID VI	1969/600
PC-8B	800/244	AUGUSTE PICCARD	2000/610
SHELF DIVER	800/244	LEO I	2000/610
MERMAID III & IV	853/260	MANTIS	2000/610
MERMAID V	984/300	OPSUB	2000/610
HAKUYO	984/300	SDL-1	2000/610
*S.M.I.	984/300	TAURUS A	2000/610
SUPERSUB I	984/300	WASP	2000/610
MERMAID II	1000/305	P2	2400/732
NEKTON A, B, C	1000/305	*JOHNSON-SEA-LINK III	2500/762
PC-1201	1000/305	BEAVER MARK IV	2700/823
PC-1202	1000/305	JOHNSON-SEA-LINK I & II	3000/914
PC-1203	1000/305	ARMS	3000/914
SKADOC 1000	1000/305	PC-16	3000/914
SNOOPER	1000/305	T-1	3000/914
PC-1801, 1802, 1804	1000/305	P3	3000/914
PS-2	1025/312	P8, P10	3280/1000
AQUARIUS I	1100/335	MOB 1, 2, 3*, 4*	3280/1000
PC-1204 & 1205	1200/366	AVALON (DSRV 1)	5000/1524
DIAPHUS	1200/366	MYSTIC (DSRV 2)	5000/1524
PC5-C	1200/366	SEA CLIFF	6500/1981
*PIONEER I	1200/366	TURTLE	6500/1981
*STAR II	1200/366	DSV-2K	6562/2000
LR2	1200/366	PISCES IV	6600/2012
MOANA I & III	1312/400	PISCES V	6600/2012
*TINRO 2	1312/400	PISCES VI	6600/2012
PC-9	1350/412	PISCES VII & XI	6600/2012
JIM	1500/457	DEEP QUEST	8000/2438
LR3, LR4*, LR5*	1500/457	CYANA	9843/3000
*MARFAB	1500/457	ALVIN	12000/3658
SEA OTTER	1500/457	TRIESTE II	20000/6096

*Characteristic sheets for these vehicles are not included.

The questionnaire in Appendix I lists the information sought for each vehicle. If the equipment listed in Appendix I is not mentioned in the description it is not on the vehicle.

In some instances, the descriptions are not as complete as in others; the reasons being that the vehicle was either under construction or newly acquired and the operator did not know at the time what direction he would take toward operational/emergency instrumentation or procedures. In other instances, entire descriptions are missing, e.g., STAR II, PIONEER I and the MARFAB Company's vehicle. In these cases, the vehicle was still in the construction stage, or the operator simply did not respond (STAR II). If the submersible was built to metric system units, metric units are presented first and their English equivalents given in parentheses and vice versa if the vehicle was built to English units.

A note of caution must be given regarding the currency of the following descriptions. All operating submersibles may undergo modifications aimed at increasing their capabilities at any time; therefore, a description of a particular vehicle which may have been accurate in January of 1978, may be rendered inaccurate by June of the same year.

The data presented in the following descriptions were obtained from the vehicle operators. In instances where various data may be inconsistent with other sources, the operator of the vehicle was considered as the primary source.

ALVIN

CHARACTERISTICS

Length.....	25 ft (7.7m)	Hatch Diameter.....	20 in. (50.8cm)
Beam.....	8.5 ft (2.6m)	Life Support Duration.....	216 man hrs
Height.....	13.1 ft (3.9m)	Total Power.....	42.7 kWh
Draft.....	7.6 ft (2.3m)	Speed: Cruise (kts/hrs).....	1/NA
Weight (dry).....	17.0 tons (15.4t)	Max (kts/hrs).....	2/NA
Operating Depth.....	12,000 ft (3,658m)	Crew: Pilot(s).....	1
Collapse Depth.....	25,000 ft (7,620m)	Observer(s).....	2
Launch Date.....	1964	Payload.....	1,000 lbs (453kg)
		Color.....	White

Pressure Hull: Spherical shape, 84 in. (213cm) OD, 1.93 in. (4.9cm) thick, composed of titanium alloy.

Power Source: Lead acid batteries, pressure-compensated, provide 30 VDC, 475 amp-hrs (eight hr rate) and 60 VDC, 475 amp-hrs (eight hr rate). Emergency power inside pressure hull provided by three nickel cadmium batteries.

Maneuvering Control: Main propulsion is provided by a trainable (50 degrees p/s), stern mounted, ten hp propeller. Two thrusters, powered by a six hp hydraulic motor, are located amidships and are 360 degrees rotatable in the vertical plane.

Pitch/Trim: A total of 550 lbs (249kg) of mercury may be pumped forward or aft to provide approximately + 17 degrees bow angle.

Life Support: Three O₂ flasks each carrying 230 SCF at 2,475 psi (174kg/cm²), all are located inside pressure hull. CO₂ is removed by scrubbing through LiOH. Monitors for O₂, CO₂, temperature, humidity and pressure. Backup monitors for O₂, CO₂ and pressure. All properties are checked once every 30 minutes.

Viewing: Four large viewports, one views forward, two view p/s of forward looking viewport, and one looks directly downward. A small viewport is located in the hatch cover. Two, fixed, external TVs with a video recorder.

Manipulator: One, jettisonable, electrically-powered, six degrees-of-freedom, 63 in. (160cm) maximum extension, scissors type claw with special adapters, 50 lbs (23kg) lift capacity at maximum lateral extension.

Lift Points: For submerged recovery a 5/8 in. (1.6cm) steel cable loop is attached to normal lift points on sphere (inside sail) and is held in a position atop the sail.

External Lighting: Ten lights total: Three are strobe lights for photography; two are 150 w thallium iodide; five are incandescent (quartz iodide) of 350 w and 750 w power. Nine illuminate forward, one illuminates aft. Configuration and number may change according to dive tasks.

Life Jackets: Three, inflatable

Distress Rockets: Twenty-four pen-light red flares are carried inside pressure hull.

Radar Reflector: Corner reflector, collapsible, wire mesh screen carried inside sail. Height above water surface is 6.5 ft (1.9m).

Surface Lights: One, flashing white, (OAR Mod. SF500), self-powered, 12 hrs duration at standard flash rate of once every two seconds, 48 hrs duration at decreasing flash rate. Height above water surface is six ft (1.8m).

Fire Extinguisher: One, dry chemical.

Emergency Food & Water: C-rations and six to ten pts (three to five l.) of canned water.

Medical Supplies: First aid kit

Surface Communications: VHF transceiver (Modar Mod. ASA 1520 AK), six channels, 156 MHz, powered off main batteries. CB (Lafayette Dycom 12A), self-powered.

Sub-Surface Communications: One underwater telephone (Straza Mod. 504), 8.0875 kHz, one transducer topside; one on keel, operates off main and emergency power.

Surface Homing Devices: Radio beacon (OAR MOD. ST-206-12RA), transmits on 27-30 MHz, self-powered. Underwater telephone. Transducer on keel.

Sonars: CTFM scanning sonar (Ametek Straza Mod. 500), 82 to 72 kHz, scans 120 degrees p/s. Pinger, 37 kHz, pilot-activated, self-powered, 14 days duration at reduced rep. rate, normal rep. rate five pings/second. Echo Sounder, 12 kHz, CRT display, 12,000 ft (3,658m) range.

Jettisonable Components: Two ascent weights of 220 lbs (99kg) each. Three batteries weighing 580 lbs (263kg) each. After vehicle body 2,430 lbs (1,102kg). Upon separation from after body the pressure hull and sail will float to surface.

Emergency Breathing: Three closed circuit systems which draw off the normal O₂ supply and use baralyme to remove CO₂. Each occupant is provided between three to six hours duration.

Communications Procedure: Check with surface every 30 minutes, dive is aborted if no contact is made within 60 minutes.

System Readiness: Operational

Classification/Certification: U.S. Navy Certified

Support Ship: DSRVT LULU

Owner: Office of Naval Research

Operator: Woods Hole Oceanographic Institute
Woods Hole, Mass. 02543

Builder: Litton Systems

Point-of-Contact: L.A. Shumaker
(Address same as operator)
Telephone: (617) 548-1400 ext. 408
Cable: OCEANINST

AQUARIUS I

CHARACTERISTICS

Length.....	13.5 ft (4.2m)	Hatch Diameter.....	18 in. (46cm)
Beam.....	6.5 ft (1.9m)	Life Support Duration.....	336 man hrs
Height.....	6.6 ft (2.0m)	Total Power.....	21 kWh
Draft.....	5.3 ft (1.6m)	Speed: Cruise (kts/hrs).....	2/NA
Weight (dry).....	6 tons (5.4t)	Max (kts/hrs).....	3.4/NA
Operating Depth.....	1,100 ft (335m)	Crew: Pilot(s).....	1
Collapse Depth.....	1,800 ft (549m)	Observer(s).....	1
Launch Date.....	1974	Payload.....	880 lbs (399kg)
		Color.....	White, orange sail

Pressure Hull: Cylindrical shape with hemispherical end caps, composed of A516 steel and acrylic plastic bow dome. Total length is 8.9 ft (2.7m), 47 in. (120cm) ID.

Power Source: Lead acid batteries inside two pressure-resistant pods provide 225 amp-hr at 120 VDC and 72 amp-hr at 12 and 24 VDC. Emergency power (10 amp-hr at 12 VDC) inside pressure hull for CO₂ scrubber and surface and sub-surface communications.

Maneuvering Control: One reversible, trainable (90 degrees p/s) stern-mounted propeller provides all propulsion and maneuvering control.

Life Support: Oxygen flasks containing 200 SCF (5.7m³) O₂ are carried inside the pressure hull. CO₂ is removed by scrubbing through LiOH. Continuous monitors for O₂, temperature, humidity and pressure. CO₂ is checked as required.

Viewing: Acrylic plastic bow dome 36 in. (91cm) diameter, four viewports girdle conning tower. External (fixed) and internal (hand-held) television with video recorder.

Manipulator: One, claw jettisonable, six degrees-of-freedom, scissors type claw with maximum opening of 7 in. (17.8cm) and grip force of 158 lbs (72kg).

Lift Point: A steel ring 6 in. (15.2cm) ID is attached to a two point nylon bridle which terminates above the conning tower. Ring lays flat during dive. Lift capacity is 6 tons (5.4t).

External Lighting: One 250 w, thallium iodide light (Hydro Products Mfg.) located on brow above bow dome.

Life Jackets: Two, inflatable

Distress Rockets: Six, red, hand-held flares carried inside the pressure hull.

Surface Lights: One, blue/white, flashing light, 3 ft (0.9m) above water surface, once/second flash rate, self-powered, 100 hours duration.

Fire Extinguisher: One, dry chemical

Emergency Food and Water: Seven pints (3.3 l.) water. Glucose and vitamin pills. Equal to seven days duration. Emersion suits carried for cold protection.

Medical Supplies: First aid kit

Surface Communications: One VHF transceiver, 5 w, 171.96 MHz.

Sub-Surface Communications: One underwater telephone (Sub Comm 200S-20), 9 and 27 kHz, may serve as pinger on 9 or 27 kHz.

Surface Homing Devices: One RDF beacon (Oar Mfg.), self-powered, 27 MHz.

Sonars: Scanning sonar (Wesmar SS130), 160 kHz, 1,600 ft (488m) range, tilttable 90 degrees downward to act as echo sounder. Pinger mode in underwater telephone, 9 or 27 kHz, one second rep. rate, self-powered, 45 days duration.

Jettisonable Components: A 375 lb (170kg) lead weight is manually releaseable. Manipulator claw can be jettisoned.

Emergency Breathing: Four (two for each occupant) closed-circuit Drager units, each provides 45 minutes breathing duration.

Communications Procedure: Check with surface every 15 or 30 minutes. Abort dive if no surface contact established within 60 minutes.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: M/V HUDSON HANDLER

Owner: Hyco Subsea Ltd.

P.O. Box 1059

Station A

Vancouver, B.C. V6C 2P1

Operator: Hyco Subsea Inc.

4800 W 34th St.

Houston, Texas 77092

Telephone: (713) 688-6382

Telex: 79-0169

Point-of-Contact: Bill Faulkner

Address same as Operator

ARGUS

CHARACTERISTICS

Length.....6m (19.7 ft)	Hatch Diameter.....52cm (20.5 in.)
Beam.....2.5m (8.2 ft)	Life Support Duration.....216 man hrs
Height.....3.7m (12.2 ft)	Total Power.....36 kWh
Draft.....2.5m (8.2 ft)	Speed: Cruise (kts/hrs)..1/7
Weight (dry)....8.5t (9.4 tons)	Max (kts/hrs)....4/NA
Operating Depth..600m (1,969 ft)	Crew: Pilot(s).....2
Collapse Depth...1,000m (3,281 ft)	Observer(s).....1
Launch Date.....1975	Payload.....300kg (662 lbs)
	Color.....Yellow

Pressure Hull: Spherical shape, 2.2m (7.2 ft) ID, 18cm (0.7 in.) thick equivalent to HY-80 steel.

Power Source: Lead acid batteries, pressure compensated, consisting of 90 each 2 V cells producing 28 V at 1,200 amp-hr capacity.

Maneuvering Control: Static: MBT of 1.4m³ (49 ft³) capacity; VBT of 130kg (286 lbs) capacity. Dynamic: Two fixed, reversible screw-type propellers mounted p/s on the stern.

Pitch/Trim: Soft bladders forward and aft can be differentially filled with oil to provide +15 degrees up/down bow angles.

Life Support: Five flasks of O₂ of 10 l. (10.5 qts) capacity each are bled continuously into hull. CO₂ is removed by scrubbing through CaOH for a period of 10-15 minutes every 30 minutes. Every 30 minutes the following properties are monitored: O₂, CO₂, temperature, humidity, pressure. Both O₂ and CO₂ monitors have backup monitoring devices.

Viewing: Four viewports total, three forward on bow and one on starboard side adjacent to sail. All have an ID of 14cm (5.5 in.).

Lift Point(s): One aft of sail "C" shaped hook with opening forward. Minimal opening 10cm (3.9 in.), 1.25cm (0.5 in.) thick, 12.5cm (4.9 in.) total length. A second circular orifice located aft of sail and is 7cm (2.75 in.) ID and made of 5.7cm (2.24 in.) thick plate steel.

Life Jackets: Three, inflatable

Surface Lights: One, flashing white light, 1.2m (3.9 ft) above water surface.

Fire Extinguisher: One, dry chemical.

Emergency Food and Water: Food and water equal to life support duration. Five l. (5.3 qts) of water and space craft type rations. Protective (thermal) clothing being investigated.

Medical Supplies: First aid kit.

Surface Communications: CB and VHF transceivers, both operate off main batteries. Range of VHF 3.7-5.6km (2-3nm).

Sub-Surface Communications: One underwater telephone, 17 kHz, CW, operates off main batteries has emergency power supply. Two transducers, one on top and one on keel of vehicle.

Jettisonable Components: A 200kg (441 lbs) lead weight is manually droppable. MBTs can be blown at operating depth.

Emergency Breathing: Closed circuit breathing sets provide one hour breathing duration for each occupant.

Communications Procedure: Check with surface every 30 minutes; if no contact in 60 minutes, dive is aborted.

System Readiness: Operational

Classification/Certification: None

Support Ship: Ship of opportunity

Owner: Academy of Sciences USSR
Moscow

Operator: P.P. Shirshov, Institute of Oceanology
Academy of Sciences USSR
1 Letnay St., Moscow 109387
USSR

Builder: Same as above.

Point-of-Contact: Mr. A. Monin, Director
Institute of Oceanology USSR
Address same as above
Telephone: 233-55-76
Cable: G-387 OCEANOLOGIYA

ARMS

CHARACTERISTICS

Length.....	8.5 ft (2.7m)	Hatch Diameter.....	22 in. (5.7m)
Beam.....	8.5 ft (2.7m)	Life Support Duration.....	190 man hrs
Height.....	10 ft (3m)	Total Power.....	30 kWh
Draft.....	8.5 ft (2.6m)	Speed: Cruise (kts/hrs)...	N/A
Weight.....	15,700 lbs (7,121.5kg)	Max (kts/hrs).....	N/A
Operating Depth.....	3,000 ft (914m)	Crew: Pilot(s).....	1
Collapse Depth.....	NA	Observer(s).....	1
Launch Date.....	1976	Payload.....	700 lbs (317.5kg)
		Color.....	White tophalf Yellow bottom

Pressure Hull: Spherical shape of HY-100 steel, 76 in. (193cm) ID.

Power Source: Lead acid batteries in two pressure resistant pods, 24 VDC at 5 kWh; 120 VDC at 25 kWh total.

Maneuvering Control: Two fixed 5 hp thrusters, reversible, variable speed.

Surface-controlled cable provides vertical movement.

Trim/Pitch Control: Clump 1,600 lbs (725.8kg) in air, 1,400 lbs (635kg) in water can be used to yo-yo vehicle up 80 ft (24.4m) and down.

Life Support: Two O₂ flasks carried externally, 300 cu ft (8.5 cu m) total at 2,015 psi. O₂ is bled into hull continuously. Soda sorb routine CO₂ absorbant, LiOH carried for back up. Monitor O₂, CO₂, temperature, humidity and pressure. O₂, temperature, humidity and pressure continuously displayed, CO₂ periodic readings are made.

Viewing: Four viewports, one 31 in. (78.7cm) diameter bow dome looking forward; three 6 in. (15.2cm) diameter aft viewports looking port/starboard and directly upward. One TV (Subsea Mfg), on pan/tilt mechanism, monitor and tape are aboard support ship.

Manipulators: Two. One (Perry-built), 3 degrees of freedom (nil in the horizontal), circular grip, jettisonable claw. One (GE-built) proaction control, force feedback, 7 degrees of freedom, 65 lbs (29.5kg) lift capacity; 1,100 Newtons grasp capacity, entire arm jettisonable.

Lift Point: Always operates from tethered cable. Four in. (10.2cm) diameter steel tubing encircles top, can lift to surface.

External Lighting: Two (Birns and Sawyer) "Snooper" quartz iodide, mounted port/starboard forward.

Life Jackets: Two, inflatable.

Surface Lights: One white flashing strobe, can be seen only looking forward, 10 in. (25.4cm) above waterline, self-powered, pressure activated.

Anchor: Clump can anchor in 80 ft (24.4m) of water.

Fire Extinguisher: One, dry chemical.

Emergency Food/Water: No provisions at present.

Medical Supplies: First aid kit.

Surface Communications: VHF, 5 w (Handic Model 43c), self-powered.

Sonars: Obstacle Avoidance: Wesmar (SS140S).

Sub-Surface Communication: Primary is a hardwire telephone which is multiplex to share its cable with the TV signal. Emergency communications provided by a Mesotech Underwater telephone (Model no. 703A), 20 w, 8 and 27 kHz.

Jettisonable Components: Both manipulators (245 lbs (111.1kg) total); clump (1,400 lbs) (635kg) manually jettisonable through hydraulic actuators.

Emergency Breathing: Two 50 cu ft (1.4 cm m) capacity scuba bottles using compressed air. Mouthpiece and face masks for each occupant carried inside hull. Portable.

Communication Procedure: Nothing established at present. Decision to abort dive due to lack of communication is undecided.

System Readiness: Operational

Classification: Applying for ABS

Owner: Oceaneering International

414 East Cota

Santa Barbara, CA 93010

Telephone: (805) 963-6526

Telex: 687472 Oceaneering SNC

Operator: Same as owner

Builder: Perry Submarine Builders

Riviera Beach, FL

Point-of-Contact: John Fike

(Address same as above)

AUGUSTE PICCARD

CHARACTERISTICS

Length.....	93.5 ft (28.5m)	Hatch Diameter.....	29.5 in. (75cm)
Beam.....	13 ft (4m)	Life Support Duration.....	90 man days
Height.....	24 ft (7.3m)	Total Power.....	740 kWh
Draft.....	13 ft (4m)	Speed: Cruise (kts/hrs)..	4/14
Weight (dry).....	185.2 tons (168t)	Max (kts/hrs).....	6/15
Operating Depth..	2,000 ft (610m)	Crew: Pilot(s).....	6
Collapse Depth...	4,921 ft (1,500m)	Observer(s).....	3
Launch Date.....	1963	Payload.....	5 tons (4.5t)
		Color.....	Dayglow orange above waterline, gray below

Pressure Hull: Cylindrical shape with two hemispherical end caps of Aldur 55/68 steel. Cylinder is 1.5 in. (3.8cm) thick, 10.25 ft (3.1m) OD and 59.7 ft (18.2m) long. Total length (including end caps) is 64.95 ft (19.8m).

Power Source: Lead acid batteries inside pressure hull and two Caterpillar Marine diesel engines driving two 85 KW generators. Emergency power is provided for navigation, life support and underwater telephone.

Maneuvering Control: One, reversible, stern propeller (75 hp), fitted with a Kort nozzle trainable in the horizontal plane. Dive planes situated forward and aft.

Pitch/Trim: Bow angles of ± 15 degrees are attainable by differentially filling internal trim tanks, 2 fwd/2 aft; 80 ft³ (2.2m³) capacity in each pair.

Life Support: Seven flasks of compressed O₂ carried in hull. Each flask has a capacity of 2,040 ft³ (57m³) at STP. Monitors for O₂, CO₂, CO, H₂, freon, temperature, humidity and pressure. O₂, H₂ and CO are continuously monitored and have an audio and visual warning when recommended tolerances are exceeded. CO₂ is removed by natural convection current passage through LiOH panels.

Viewing: Forty three viewports total, but only three in the bow are used for viewing. One TV camera (Hydro Products TC-125-SIT) mounted on pan & tilt device.

Lift Point(s): Two hard patches are contained in the keel structure to which a sling or cradle can be attached.

Lighting (underwater): Two, 250 w, thallium iodide.

Life Jackets: Eight Mustang Floater coats for survival and two complete Floater suits for topside watch crew.

Distress Flares: Carried in pressure tight container in sail.

Radar Reflector: Carried in mast of sail.

Surface Lights: As required by Certifying Authority. Main steaming light, p/s bow lights, forward and stern steaming lights.

Anchor: Fifty pound (23kg) Danforth with chain and line.

Fire Extinguisher: Six, dry chemical. Halon drench system.

Emergency Food & Water: Is equal to total life support duration. Also carries protective clothing.

Surface Communications: Two multi-channel VHF/FM units, SSB for offshore use.

Sub-Surface Communications: Two systems carried. Prime system (Mesotech 703A) operates on 8 or 27 kHz, secondary (Straza ATM 504A) on 8.3 to 10.7 kHz. Transducer topside and on keel.

Surface Homing Devices: One 37 kHz sounding continuously, directional hydrophone assembly available for emergency location.

Sonars: Scanning sonars: Two, one mounted topside; one on keel. Topside: Straza CTFM (Mod. 503), 87 to 72 kHz, 360 degree scan, 1,600 ft (488m) max. range.

Keel: Wesmar SS1405. Side Scan Sonar: One, EG&G (Mod. Mark 1B), 105 ± 10 kHz, max. range 1,640 ft (500m).

Marker Buoys: One, details not available.

Life Rafts: Two, six person capacity each.

Emergency Buoyancy: Manually (via hydraulic) droppable 7 ton (6.4t) weight.

Emergency Breathing: Twelve full face masks, which can plug into any of 18 quick-connect sockets, draw off 660 ft³ (18.5m³) of compressed air at STP from piping running throughout submersible. Two face masks in vehicle control area allow user mobility. Six, standard scuba sets for rescue.

Egress Procedure (underwater): Facilities are available to flood pressure hull and allow personnel to exit using the reserve scuba.

System Readiness: Submarine system under continuous development, presently available for offshore surveying.

Classification/Certification: ABS. Certified by Canadian.

Ministry of Transport.

Support Ship: None at time of survey; will use ship of opportunity. Ultimately seeking independent operations.

Owner: Horton Maritime Explorations, Ltd.

1174 Welch St.

No. Vancouver, B.C. V7P1B2

Canada

(604) 980-8591

Operator: Same as above

Builder: Giovanola Bros.

Monthey, Switzerland

Point-of-Contact: Mr. John Horton

(Address same as above)

Telephone: (604) 980-8591

BEAVER MARK IV

CHARACTERISTICS

Length.....	24 ft (7.3m)	Hatch Diameter.....	25 in. (64cm)
Beam.....	9.5 ft (2.9m)	Life Support Duration.....	360 man hrs
Height.....	10.3 ft (3.1m)	Total Power.....	44 kWh
Draft.....	6.6 ft (2.0m)	Speed: Cruise (kts/hrs).....	2.5/10
Weight (dry).....	17 tons (15.4t)	Max (kts/hrs).....	5.7/NA
Operating Depth....	2,700 ft (823m)	Crew: Pilot(s).....	1
Collapse Depth.....	NA	Observer(s)/diver(s).....	1/3
Launch Date.....	1968	Payload.....	2,000 lbs (907kg)
		Color.....	Orange

Further design, operational and equipment details are not available until the major refitting program is completed.

System Readiness: Undergoing major overhaul which includes installation of a plastic bow dome. Planned to be operational by spring of 1979.

Classification/Certification: None.

Support Ship: Ship of Opportunity

Owner: International Underwater Contractors, Inc.

Apartado Postal 1450

Panama 1, Panama

Operator: International Underwater Contractors, Inc.

P.O. Box 95

City Island, N.Y. 10464

Builder: North American Rockwell Corp.

Seal Beach, Ca.

Point-of-Contact: Mr. Booker T. Washington

International Underwater Contractors

264 Fordham Place

City Island, N.Y. 10464

Telephone: (212) 885-0600

Cable: TECHDIVER NY

Telex: 147242

CONSTRUCTOR

CHARACTERISTICS

Length.....15.25 ft (4.6m)	Hatch Diameter.....27 in. (69cm)
Beam.....11 ft (3.4m)	Life Support Duration.....144 man hrs
Height.....11.8 ft (3.6m)	Total Power.....45 KW continuous
Draft.....11 ft (3.4m)	Speed: Cruise (kts/hrs)...3 knots/unlimited
Weight (Dry).....9 tons (8.2t)	Max (kts/hrs).....3 knots/unlimited
Operating Depth.....1,600 ft (488m)	Crew: Pilot(s).....1
Diver Lockout Depth.1,600 ft (488m)	Observer/Diver.....1
Collapse Depth.....NA	Payload.....2,300 lbs (1,042kg)
Launch Date.....1977	Color.....White

Pressure Hull: Cylindrical shape, composed of steel covered with syntactic foam for buoyancy and insulation. Hull inside height is 82.6 in. (209.8cm), ID is 62.9 in. (159.8cm) and thickness is 19mm (.74 in.).

Power Source: Routine power is supplied from a surface generator providing 440 volts, 3 phase, 60 Hz. Emergency power is obtained from pressure-compensated, lead acid batteries providing 24 VDC, 180 amp-hrs.

Maneuvering Control: Four, reversible, 10 hp each, thrusters. Two are mounted port/starboard and are 180 degrees rotatable in the vertical. One is mounted forward and is fixed to provide lateral motion. One is mounted on the stern and is trainable 90 degrees left/right.

Trim/Pitch Control: Two variable ballast tanks (1 fwd; 1 aft) of 900 lbs (408kg) capacity each can be individually controlled to provide ± 10 degrees bow angle.

Life Support: Primary oxygen supply is through an umbilical to the surface which also supplies diver hot water for heating. 160 SCF (4.5m³) of emergency O₂ is carried onboard. CO₂ is removed by scrubbing through soda sorb. Monitoring devices for O₂, CO₂ (with backup), temperature and internal pressure. Monitoring is continuous.

Viewing: Eight viewports with 8 in. (20.3cm) diameter. Three are forward, 2 p/s 2 aft and 1 is oriented vertically upward. Television camera mounted externally on pan/tilt mechanism.

Manipulator: Two, one is 5 degrees of freedom and one is 7 degrees-of-freedom both are hydraulically powered. Five degrees-of-freedom manipulator has a 69 in. (175cm) reach, 400 lb (181kg) lift capacity and Dorrance type claw. Seven degrees-of-freedom manipulator has a 64 in. (163) reach, 200 lbs (90kg) lift capacity and a scissors type claw.

Lift Point: A metallic ring attached to the vehicle by a two-part nylon sling.

External Lighting: Four 1000 watt, quartz iodide lights and two 250 watt, tungsten halogen lights. Two are mounted p/s, 1 forward, 1 on the 5 degrees-of-freedom manipulator and 2 on the pan/tilt mechanism.

Life Jackets: Two, inflatable.

Surface Lights: One, flashing white, strobe light mounted 3 ft (0.9m) above the water surface.

Fire Extinguisher: One, dry chemical

Emergency Food & Water: One gal. (3.7 l) potable water. Two floatation/survival suits. Two complete wet suits.

Medical Supplies: First aid kit.

Surface Communications: Hardwire (Helle 3312) unscrambler and one sound-powered phone, both through umbilical.

Sub-Surface Communications: Hardwire phones as described above. For emergency use there is an underwater telephone (Helle Mfg.), 42 kHz which uses a topside-mounted transducer and operates off the emergency power.

Communications Procedure: Continuous, not at prescribed intervals. Dive is aborted if communications system fails.

Sonars: Scanning Sonar (Wesmar SS140S), 160 kHz, 360 degree scan. Pinger receiver (Telstar/EMP Mfg.), 0-100 kHz.

Jettisonable Components: Umbilical cable and landing pod of 150 lbs (168kg). Both are mechanically released.

Emergency Breathing: Full face masks, open circuit. Breathing gas is supplied from the surface umbilical and pressure is vented through the umbilical. Two (Innerspace Mfg.) closed-circuit rebreathers are also carried.

Egress Procedure: In accordance with diver lockout procedures.

System Readiness: Began sea trials May 1978

Classification/Certification: DNV

Support Ship: DDS SALVAGER

Owner: Deep Diving Systems, Ltd.

P.O. Box 2717

Thunder Bay, Ontario

Canada P7B5G2

Operator: Same as owner

Builder: Same as owner

Point-of-Contact: Same as owner

Telephone: (807) 344-5867 or (807) 344-7621

Telex: 073-4514

CYANA

CHARACTERISTICS

Length.....5.7m (18.7 ft)	Hatch Diameter.....400mm (15.7 in.)
Beam.....3.04m (4.5 ft)	Life Support Duration.....216 man hrs
Height.....2.10m (6.9 ft)	Total Power.....47 kWh
Draft.....2.08m (6.8 ft)	Speed: Cruise (kts/hrs)...1/10
Weight (dry).....8.5t (9.4 tons)	Max (kts/hrs).....2/5
Operating Depth...3,000m (9,843 ft)	Crew: Pilot(s).....1
Collapse Depth...3,900m (12,795 ft)	Observer(s).....2
Launch Date.....1970	Payload.....199kg (490 lbs)
	Color.....Yellow

Pressure Hull: Spherical shape composed of Vascojet 90 steel, 2,001mm (79 in.) OD and 30.5mm (1.2 in.) thick.

Power Source: Lead acid batteries, pressure compensated, 62 cells rated at two V each with a 380 amp-hr capacity. Both 120 VDC and 24 VDC are supplied.

Maneuvering Control: Static: Vehicle is negatively buoyant when launched and held on surface by three buoys until ready to dive. Weight is released at operating depth to attain neutral buoyancy. Additional weight (lead shot) is released to surface. Negative buoyancy can be obtained by introducing sea water into four titanium spheres. Dynamic: Two, screw-type, reversible, one-speed propulsers mounted p/s forward; 2.5 hp each.

Pitch/Trim: Mercury can be transferred forward or aft to obtain up/down angles of ± 28 degrees.

Life Support: Three flasks of O₂ with volume of seven l (7.4 qts) each are carried in the pressure hull and bled continuously into the sphere. CO₂ is removed by scrubbing through soda sorb. O₂, CO₂, temperature, humidity and pressure are monitored and checked every 30 minutes. Cabin air is also blown through calcium chloride to lower humidity.

Viewing: Two large viewports of 110mm (4.3 in.) ID are located forward just below the equatorial axis. A smaller camera viewport is situated between and just above the two large ports. An external, fixed, TV camera is carried and includes a video recorder.

Manipulators: One, jettisonable, hydraulically-powered, 1.8m (6 ft) maximum length, five degrees-of-freedom with a lift capacity of 20kg (44 lbs) at maximum extension and 50kg (110 lbs) maximum lift. Claws and terminations include parallel jaws, scissors and a rotary steel cutter.

Lift Point(s): The emergency lift point consists of an 8mm (0.3 in.) diam. stainless steel wire rope with one end attached to the main lift point and the other end terminating at the stern in a 15cm (5.9 in.) diam. loop. The cable is capable of two t (2.2 tons) lift. A two-pronged, fishhook-like, spring-loaded, toggle device is carried aboard the support ship. This device is designed to be carried down to CYANA by another vehicle and inserted into the loop for surface retrieval to a depth where additional lift lines may be attached.

External Lighting: Three lights total, one of 500 w and two of 750 w, all are quartz iodide and mounted on brow.

Life Jackets: Three, inflatable (Fenzy type).

Life Rafts: Three, one-man, inside hull.

Distress Rockets: Ten, red color, stored inside hull.

Radar Reflector: One, tetrahedron-shaped, permanently affixed, 0.6m (2 ft) above water line.

Surface Lights: Flashing white, 1/sec rep. rate, 0.6m (2 ft) above surface, pilot activated, operates off main batteries.

Fire Extinguisher: One, dry chemical

Emergency Food & Water: Three day food supply (life boat-type rations) and 9 l (9.5 qts) water. Occupants' clothes are chemically treated to be inflammable.

Surface Communications: One VHF, 27 MHz, two channels, 5-10nm (9-18 km) range, powered off main batteries.

Sub-Surface Communications: Two systems, one was designed and built by the French Navy. It operates on 8 kHz and also serves as a transponder and echo sounder. The second (CSF Thompson Mfg.) operates on 8 kHz and has CW capability. Both transducers are mounted topside.

Surface Homing Devices: Self-powered, 27 MHz, five day duration, radio beacon (OAR Model) automatically activates upon surfacing. RDF on support ship.

Sonars: Straza CTFM Sonar Model 500, range 10-1,500 m, 360 degree scan, interrogates between 40-55 kHz, can act as transponder in 72-87 kHz transmitting range. Pinger: One, (Burnett Electronics Mod. 597), 37 kHz, salt water activated, rep. rate 2/sec., self-powered. Echo Sounder: Downward-looking, 120 kHz, 200m (656 ft) range (Data Marine Mfg.). Transponder: One, (CSF Thompson), self-powered interrogation frequency 16 kHz, responding frequency 17 kHz.

Jettisonable Components: Batteries: 185kg (408 lbs); manipulator: 70kg (154 lbs); descent weight: 120kg (264 lbs); trim weight (shot): 200kg (441 lbs); mercury 95kg (210 lbs).

Emergency Breathing: Three Fenzy special O₂ breathing devices of 3 hours each duration.

Communications Procedure: Communications check with surface every 30 minutes; abort dive if no contact within 45 minutes.

System Readiness: Operational

Classification/Certification: None, under review by Veritas

Support Ship: Ship of opportunity

Owner: Centre National Pour L'Exploration des Oceans (CNEXO)
66 Avenue d'Iena
75016 Paris
France

Operator: Genavir
Z. P. de Bregailon
83500 Laseyne
France

Builder: Centre d'Etudes Marines Avances (CEMA)

Point-of-Contact: Claude Caillart
Genavir, Laseyne
(Address same as operator)
Telephone: (94) 94.36.01
Telex: 400.662

DEEP QUEST

CHARACTERISTICS

Length.....	39.9 ft (12.2m)	Hatch Diameter.....	20 in. (51cm)
Beam.....	19 ft (5.8m)	Life Support Duration.....	204 man hrs
Height.....	13.25 ft (4.04m)	Total Power.....	230 kWh
Draft.....	8.6 ft (2.6m)	Speed: Cruise (kts/hrs)..	2/18
Weight (dry).....	52 tons (47t)	Max (kts/hrs).....	3/12
Operating Depth..	8,000 ft (2,438m)	Crew: Pilot(s).....	2
Collapse Depth...	13,000 ft (3,962m)	Observer(s).....	2
Launch Date.....	1967	Payload.....	3 tons (2.7t)
		Color.....	White, orange sail and rudder

Pressure Hull: Bi-sphere shape, each sphere is 0.895 in. (2.3cm) thick, 7 ft (2.1m) OD and made of 18% nickel, KSI grade maraging steel. Spheres are welded together and connection between the two is a 20 in. (51cm) diam. opening.

Power Source: Main power is derived from two 115 VDC, pressure-compensated lead acid batteries mounted below and between the bi-spheres. Two 28 VDC silver zinc batteries are carried in the pressure hull to provide 3.6 kWh emergency power.

Maneuvering Control: Forward and reverse thrust is from two, reversible, stern-mounted, 7.5 hp AC motor-driven propellers. Vertical thrust is from two fore and aft mounted, 7.5 hp AC motors and ducted propellers. Lateral thrust is from fore and aft mounted water jets powered by two 7.5 hp, AC motors. A rudder and stern planes provide additional underway steering control.

Pitch/Trim: A 30 degree up or down bow angle can be produced by transferring 1,400 lbs (652kg) of oil and mercury between two fore and aft mounted, 18 in. (46cm) diam., spherical, steel tanks. A 10 degree port or starboard list can be attained by transfer of 828 lbs (375kg) of mercury between two 15 in. (38cm) diam. tanks. Both trim and list systems are pressure-compensated.

Life Support: Four 0.37 ft³ (0.03m³) volume tanks supply oxygen for normal usage. Carbon dioxide is removed by LiOH. Oxygen level is automatically monitored and regulated. Emergency breathing is by four full face masks connected to an oxygen-demand system for survival periods of 12 man hrs. Temperature and humidity are automatically regulated. Warning light and buzzer activate when O₂ and CO₂ reach prescribed values. Heaters available, but rarely required. Trace contaminants can be monitored, but experience shows it to be unnecessary.

Viewing: Two acrylic plastic viewports are provided; one is located on the axis of the forward sphere and is a few degrees below the horizontal. It is 9 in. (23cm) OD, three in. (8cm) ID. The second is in the aft sphere and looks directly downward. It is 15 in. (38cm) OD, five in. (13cm) ID. The aft viewport is equipped with an optical remote viewing system of 180 degree objective in the vertical and 360 degree in the horizontal. Four television cameras: Three on pan and tilt devices, one fixed.

Manipulator(s): Two manipulators, six degrees-of-freedom, jettisonable, total length 72 in. (1.8m), lift capacity of grip rated at 300 lbs (226kg), parallel jaws-type claw.

Lift Point(s): A rope bridle is rigged p/s between two lift points aft of the sail and tied off to a wire line running between sail and rudder. Attachment of lift hook to this bridle can lift vehicle to surface in nose-down position.

Lighting (underwater): Between 10 to 12 lights are carried. Eight are fixed on the bow and are 500 watts each. Two illuminate area under after hatch.

Life Jackets: Four, inflatable

Distress Flares: Very pistol, four shells, parachute-type flares, red, carried outside of pressure hull.

Surface Lights: One (Benthos Mod. 2001), flashing white strobe (1 flash/2 secs) mounted six ft (1.8m) above water surface, self-powered, 40 hrs duration, pressure-activated switch.

Fire Extinguisher: Two, dry chemical

Emergency Food & Water: Life boat type rations carried to equal 204 man hrs life support duration. One gal. (3.8 l.) water carried.

Automatic Deballasting: If main power fails, 1,800 lbs (815kg) of iron shot will drop.

Surface Communications: VHF transceiver, 9 channels (plus weather) Heathkit 10 watt.

Sub-Surface Communications: One, (Straza Mod. 504) transmits/receives on 8.0875 kHz, operates off main batteries, has two transducers, one topside and one on keel.

Surface Homing Devices: 1) Emergency Radio Beacon (Martek Mod. EB-1B), pilot activated, self-powered, 48 hrs duration, 5.6 V, 121.5 MHz (compatible with Coast Guard Rescue frequency). 2) Submersible Beacon Transmitter (OAR Mod. ST 200) self-powered, 12-100 hrs duration, automatically transmits when reaches surface. Used in conjunction with support craft RDF to determine that sub has surfaced.

Sonars: Pingers: 2 each, both 48 hrs duration, 27 kHz, 2 sec. rep. rate, and self-powered. One pinger is omnidirectional and one is directional looking upward in a 30 degree cone. Omnidirectional pinger is to maintain general contact with sub from surface ship. Unidirectional pinger is used to position support ship directly over submersible for position fixing. CTFM Sonar: (Straza Mod. 500) with ranging and transponder interrogation capability, 87 to 72 kHz, 1,500 yd (1,372m) range.

Emergency Buoyancy: Iron shot: 1,800 lb (815kg); mercury: 800 lbs (362kg); forward battery cells: 3,500 lbs (1,591kg)

Emergency Breathing: A closed-circuit, four-man system using pure oxygen provides three hrs duration/man. All breathing devices draw off the same regulator. CO₂ is scrubbed within the system.

Communications Procedure: Check with surface every 15 minutes. Loss of communications is not an abort situation. Vehicle is given permission to dive for a specific time period; if no contact after this time period, the dive is aborted.

System Readiness: Submersible has not dived since Nov. 1973. TRANSQUEST is operational and has been supporting the DSRV test and training programs.

Classification/Certification: Was USN certified, but tenure has expired.

Support Ship: M/V TRANSQUEST

Owner: Lockheed Ocean Laboratory
3380 N. Harbor Drive
San Diego, Ca. 92101
Telephone: (714) 298-8245

Operator: Lockheed Ocean Laboratory
(Address same as above)

Builder: Lockheed Missiles & Space Co.
Sunnyvale, Ca.

Point-of-Contact: Mr. R.A. Tyrrell
Lockheed Ocean Laboratory
(Address and telephone number same as owner)

MYSTIC & AVALON (DSRV 1 & 2)

CHARACTERISTICS

Length.....49 ft 4 in. (15m)	Hatch Diameter.....Upper: 28 in. (71cm) Lower: 24.87 in (63.2cm)
Beam.....8 ft 2 in. (2.5m)	Life Support Duration.....384 man hrs
Height.....11 ft 5 in. (3.5m)	Total Power (kWh).....156.8 kWh
Draft.....9 ft 11 in. (3m)	Speed: Cruise (kts/hrs).....NA
Weight (dry).....38.2 tons (34.6t)	Max (kts/hrs).....3.9/.5(#2) 3.9/.5(#1)
Operating Depth...5,000 ft (1,524m)	Crew: Operator(s).....2
Collapse Depth...7,500 ft (2,286m)	Life Support Operators.2
Launch Date.....1970 & 1971	Rescuees.....24 (ultimately)
	Payload.....NA
	Color.....Olive, white trim, and orange stripes

Pressure Hull: Three spheres composed of HY-140 steel, 88.6 in. ID (225cm), 0.7 in. (1.8cm) nominal thickness. Skirt (stub) 1 in. (2.54cm) thick. Transfer skirt 0.41 in. (1.04cm) thick.

Power Source: Two, silver zinc 112 VDC batteries, pressure-compensated, rated at 700 amp-hrs for each battery. Silver zinc batteries, inside hull, 28 VDC at 70 amp-hrs, provides power for underwater telephone, surface communications, interior communications, alarm panel, CO₂ scrubber, O₂ control, tracking (pinger/transponder) beacon, jettisoning systems, main ballast air blow, some mating valves, internal lighting, homing transponder drop, and main circuit breakers.

Maneuvering Control: Main forward propulsion is provided by a 5 ft (1.5m) diameter, stern-mounted, reversible propeller, 15 hp. A shroud around the propeller can be tilted to provide pitch and yaw motion. Four ducted thrusters, two vertical and two horizontal, each is reversible and 7 1/2 hp.

Pitch/Trim: Mercury trim system can provide +45 degrees bow angle. Roll angles of 45degrees can be obtained by transferring list system mercury.

Life Support: O₂ carried inside hull 360 ft³ (10m³) at 3,000 psi (210kg/cm²). LiOH is used to scrub CO₂. O₂, CO₂, temperature, humidity and pressure are monitored every 15 minutes and recorded every 30 minutes.

Viewing: Five ports. Two in control (forward) sphere, one looks down and forward and one looks down and aft but is inaccessible. Three in mid-sphere, two are located p/s and look forward and down, one is in the lower hatch cover and looks directly down. Six television cameras, five are external and one is inside the hull (video recorder optional).

Manipulator(s): One, hydraulically-powered, six degrees-of-freedom, parallel jaws type claw (with cable-cutting and water jetting capability), jettisonable.

Lift Point(s): Two points located on top of vehicle, one forward and one aft. Each point consists of a 1.25 in. (3.2cm) thick shackle which rotates forward or aft on a pin. The internal configuration is that of a rectangle with one end a hemisphere, maximum ID is 3.6 in. (9.4cm); minimum ID is 2 in. (5cm). Each shackle is sufficiently strong to lift the vehicle to some point beneath the surface where divers can attach lifting lines.

External Lighting: Seventeen lights total. Thirteen are mercury vapor lights of 175 watts each; four are quartz iodide of 75 watts each.

Life Jackets: Twenty-eight, inflatable.

Surface Lights: One, xenon flashing orange, self-powered, pressure-activated, one flash every two seconds. Duration is 40 hrs plus.

Fire Extinguisher: Three, carbon dioxide

Emergency Food & Water: Ten cans of water, 10 pts (4.7 l) capacity each.

Medical Supplies: Three first aid kits.

Surface Communications: One UHF radio transceiver, 20 watts, multi-channel, frequency is 225 to 399.95 MHz, 15 nautical mile (28km) range.

Sub-Surface Communications: One, underwater telephone, 8.0875 kHz, (Ametek/Straza Mfg.), CW, two transducers: top is conical beam, bottom is omnidirectional.

Surface Homing Devices: Radio transceiver can be used as an emergency radio beacon.

Sonars: Two CTFM scanning sonars (Ametek/Straza Mfg.), one is trained to scan horizontally (with transponder interrogation capability), 4,500 ft (1,372m) range, CRT display, 72 to 87 kHz frequency; the second is trained to scan vertically, 1,500 ft (457m) range, CRT display, 199 to 225 kHz frequency. One short range sonar, 15 ft (4.6m) range on frequency of 1 MHz; 150 ft (45.7m) on frequency of 116 kHz. One altitude/depth sonar with recorder, 12,000 ft (3,658m) on 24 kHz frequency. One Transponder Interrogator sonar, 12,000 ft (3,658m) range, 7 kHz, receiving from 12.5 to 17 kHz. Doppler Sonar navigator, 300 kHz. Tracking Transponder/Pinger 15,000 ft (4,572m) range, can ping continuously (once every five seconds) and respond between 12.5 to 17.0 kHz at .5 kHz steps. Two, droppable, homing transponders, 12,000 ft (3,658m) range, 12.5 to 17.0 kHz receive/respond range.

Jettisonable Components: Manipulator, pan & tilt units (two each). Trim and list mercury of 3,450 lbs (1,565 kg) total weight in air.

Emergency Breathing: Twenty-eight full face masks, closed-circuit, drawing off O₂ and N₂ tanks, exhale through LiOH. This is the same O₂ system used for the normal life support.

Egress Procedure: Crew can emergency exit on surface by pressurizing central sphere to ambient and egressing via lower hatch.

Communications Procedure: Surface contact check every 30 minutes, if no contact can be established within 30 minutes, the dive is aborted.

System Readiness: Completed final operational and evaluation tests and assuming rescue mission standby status.

Classification/Certification: USN certified to 5,000 ft. (1,524m)

Support Ship: Nine fleet submarines and two ASRs.

Owner: U.S. Navy

Operator: Submarine Development Group One
San Diego, CA 92132

Builder: Lockheed Missiles & Space Co.
Sunnyvale, CA.

Point-of-Contact: Commander
Submarine Development Group One
San Diego, CA 92132
Telephone (714) 225-6583

DIAPHUS

CHARACTERISTICS

Length.....	19.8 ft (6.0m)	Hatch Diameter.....	19 in. (48.3cm)
Beam.....	6.5 ft (2.0m)	Life Support Duration.....	180 man hrs
Height.....	8.2 ft (2.5m)	Total Power.....	16 kWh
Draft.....	6.3 ft (1.9m)	Speed: Cruise (kts/hrs).....	NA
Weight (dry).....	5 tons (4.5t)	Max (kts/hrs).....	3/NA
Operating Depth.....	1,200 ft (366m)	Crew: Pilot(s).....	1
Collapse Depth.....	1,800 ft (549m)	Observer(s).....	1
Launch Date.....	1974	Payload.....	900 lbs (408kg)
		Color.....	White conning tower and MBTs are inter- national orange, p/s air tanks black

Pressure Hull: Cylindrical shape with conical after end cap and plastic bow dome. Composed of A516 Grade 70 normalized steel 7/16 in. (1.0cm) thick.

Power Source: Lead acid batteries in jettisonable, pressure-resistant pod. A total of 17 batteries, divided into five banks (three batteries each) to provide 36 volts, and into one bank (two batteries each) to provide 12 volts.

Maneuvering Control: A stern-mounted, reversible propeller provides fore/aft motion and is powered by a three hp Cushman golfcart motor. Dive plane and rudder (both manually operated) provide dynamic maneuvering control.

Life Support: Eight tanks of O₂ are carried in pressure hull. Each tank is 22 ft³ (0.6m³) capacity each at 2,150 psi (150kg/cm²). CO₂ scrubber compound: LiOH. Four emergency cannisters are carried on each dive in addition to that already in the scrubber. Spare scrubber motor carried. O₂ monitored continuously (Bio Marine 222), CO₂ monitored every 30 minutes (Bacharach). Altimeter.

Viewing: Plastic bow dome 36 in. (91.4cm) diam., 2 in. (5.1cm) thick and protected by a 0.5 in. (1.3cm) thick plastic cover which free-floods with sea water. Seven viewports in conning tower 8 in. (20.3cm) OD.

Manipulator: One, non-jettisonable, three degrees-of-freedom with linear extension. Scissors-type claw 7 in. (17.8cm) maximum opening. Total arm length 5.3 ft (1.6m), 100 lbs (45kg) static lift maximum.

Lift Point: One, 1.5 in. (3.8cm) shackle with a 1 in. (2.5cm) pin. Shackle lays flat during dive, OD 7 in. (17.8cm) least ID 3 7/8 in. (9.8cm), max. ID 4.5 in. (11.4cm).

External Lighting: One (Birns & Sawyer), 150 w incandescent mounted on underside of dive plane to allow training in the vertical. One 375 w Benthos flood light.

Life Jackets: Two, inflatable

Surface Lights: Xenon, white-flashing 44 in. (111.8cm) above water surface, self-powered on main batteries, one sec. rep. rate, 15 days duration (OAR SF501-100)

Fire Extinguisher: One, Halon

Medical Supplies: First aid kit.

Emergency Food & Water: Two gals (7.6 l) water. No emergency food supply.

Surface Communications: 12 channel, 1 or 25 watt VHF-FM marine band with channels 13 & 16.

Sub-Surface Communications: Sub Comm 100S 20B and 200S 20B, 8 & 27 kHz frequency. Can also serve as pinger on 10 kHz. Power from main batteries and from emergency batteries in-hull. Surface contact made every 15 minutes; if no contact after 30 minutes, dive is aborted.

Surface Homing Devices: RFD signal powered from emergency battery system or main batteries. Transmits on 27.145 kHz. Receiver is an OAR "Finder's Receiver" F4206 and receives on 2.145 MHz.

Sonars: Emergency (Helle) pinger, 27 kHz, one sec. rep. rate. Operates off emergency power, or main batteries.

Marker Buoys: Surface buoy towed during every dive.

Emergency Buoyancy: Battery pod and portion of instrument rack manually jettisonable.

Emergency Breathing: Two scuba regulators draw off both main ballast air tanks.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: R/V GYRE or similar low-freeboard ship

Owner: Texas A&M University
College Station, Tx 77843

Operator: Martech International
Houston, Tx

Builder: Perry Submarine Builders
Riviera Beach, Fla.

Point-of-Contact: Mr. R. Starr
Martech International
1802-D Afton Drive
Houston, Tx 77055
Telephone: (713) 682-1601
Telex: 24094

DSV-2K (Tentative)

CHARACTERISTICS

Length.....	31.5 ft (9.6m)	Hatch Diameter.....	19.7 in. (50cm)
Beam.....	9.8 ft (3m)	Life Support Duration.....	80 man hrs
Height.....	8.9 ft (2.7m)	Total Power.....	61.6 kWh
Draft.....	7.5 ft (2.3m)	Speed: Cruise(kts/hrs).....	1/NA
Weight (dry).....	27.6 tons (25t)	Max(kts/hrs).....	3/NA
Operating Depth.....	6,562 ft (2,000m)	Crew: Pilot(s).....	2
Collapse Depth.....	10,827 ft (3,300m)	Observer(s).....	1
Launch Date.....	1981 (planned)	Payload.....	220.5 lbs (100kg)
		Color.....	Undecided

Pressure Hull: Spherical shape composed of high strength quenched and tempered NS90 steel. 7.2 ft (2.2m) ID, 1.3 in. (34mm) thick.

Power Source: Ag-Zn oil-filled batteries 108 V, 285 amp-hr located out of the hull a little aft of midship. Emergency Power provided by Ni-Cd enclosed type battery, 28 V, 20 amp-hrs, settled in hull.

Maneuvering Control: Dynamic: One 5.4 hp AC motor located at the end of the vehicle. Two 2 hp AC motor located both sides of midship. Static: Two main ballast tanks naturally flood-in and air-blow system, 99.4 cu ft (2.8 m³) capacity. Vertical ballast tank 369.6 qts (350 l.) capacity, sea water pump system. Shot ballast system with 661.5 lbs (300 kg) capacity.

Pitch/Trim: ±10 degrees may be obtained by transferring oil in mercury-trimming system.

Life Support: Three flasks of O₂ (150kg/cm²) totalling 63.4 qts (60 l.) are carried in the pressure hull. CO₂ is removed by scrubbing with activated charcoal. O₂, CO₂, temperature, humidity and pressure are monitored continuously. Backup O₂ and CO₂ monitors, Drager type, carried for emergency use.

Viewing: Two viewports, 4.7 in. (120mm) diameter, located forward just below the equatorial axis. One cameraport, 3.1 in (80mm) diameter, located above and between viewports. An external, pan and tilt mounted TV camera is located fore of the outer hull under the eave.

Manipulators: One, hydraulically powered, six degrees-of-freedom with 4.9ft (1.5m) maximum reach and 22.1lb (10kg) lift capacity at maximum reach, jettisonable.

Lift Points: Two, male-female type, located fore and aft of midship. Made of titanium alloy 38.6 tons (35t) capacity each.

External Lighting: Six lights, halogen lamp, 500 w each located under the eave.

Life Jackets: Three inflatable.

Surface Lights: One flash lamp located about 6.6ft (2m) above water line. Flashes every 2 seconds, 100 hours duration.

Fire Extinguisher: One portable chemical.

Surface Communication: One wireless, press talk type, 400 MHZ (UHF), 5 w output, powered from the emergency battery.

Sonars: CTFM type, one transponder, one fixed directional antennae.

Marker Buoys: One set.

Sub-Surface Communications: Two with 8.087 KHz frequency each, powered by DC 28 V, transducers mounted on top and bottom of the vehicle.

Jettisonable Components: Two drop weights, 330.8 lbs (150kg) each located bottom of midship; manipulator, 220.5 lbs (100kg) located fore of the outer hull; shot ballast approx. 662 lbs (300kg) located bottom of midship; all can be released by main or emergency battery.

Emergency Breathing: Three closed circuit systems which provide 2.5 hrs duration each.

System Readiness: Under construction

Certification/Classification: NK

Support Ship: Mono-hull type

Owner: JAMSTEC (Japan Marine Science and Technology Center)

Natsushima cho 2-15

Yokosuka 237

Kanagawa

Japan

Operator: Same as owner

Builder: Mitsubishi Heavy Industry

Wadamisaki cho 1-1-1

Hyogo-ku

Kobe

Hyogo

Japan

Point-of-Contact: JAMSTEC

(Address same as owner)

Telephone: 0468-65-2865

Cable: JAMSTEC

GLOBULE

CHARACTERISTICS

Length.....	2.7m (8.9 ft)	Hatch Diameter.....	510mm (20.1 in)
Beam.....	1.8m (5.9 ft)	Life Support Duration.....	192 man hrs
Height.....	1.7m (5.6 ft)	Total Power.....	13.5kWh
Draft.....	NA	Speed: Cruise (kts/hrs)....	2/6
Weight (dry).....	2.7t (3 tons)	Max (kts/hrs).....	NA
Operating Depth.....	183m (600 ft)	Crew: Pilot(s).....	1
Collapse Depth.....	NA	Observer(s).....	1
Launch Date.....	1973	Payload.....	250kg (552 lbs)
		Color.....	White and red

Pressure Hull: One steel sphere, 4.6 ft (1.4m) OD

Power Source: Lead acid batteries in pressure-resistant pods, 120V at 100 amp-hr and 24V at 65 amp-hr.

Maneuvering Control: Five, fixed, reversible screw-type propellers. Two provide main forward propulsion, two are vertical and one is a lateral thruster.

Trim: Two hard tanks of 40 l (10.6 gal) capacity each.

Life Support: Oxygen is carried externally in two tanks of 25 l (6.6 gal) capacity each at 200 bars (2900 PSI). Carbon dioxide is removed by scrubbing through soda lime of which 70 kg (154 lbs) is carried on each dive. The CO₂ scrubbers have emergency power inside the pressure hull. Monitors for O₂, CO₂, temperature, pressure.

Viewing: Seven dome-shaped viewports 51 cm (21.5 inch). Six girdle the hull equator, one in the hatch.

Manipulator: Optional.

External Lighting: Six lights, all quartz iodide and all 300 watts each and three security lights.

Life Jackets: Two, inflatable.

Surface Lights: One flashing, self powered, white light, rep rate once every two seconds, 50 cm (20 in) above water surface.

Fire extinguisher: One, dry chemical.

Emergency Food and Water: Equal to life duration support.

Surface Communications: VHF (SVENSKA mod. ME 60) multi-channel transceiver, 25 watts power. Emergency and identification communications on channel 16 (156-180 MHz) five channels for normal communications 10 km (5.4nm) range.

Sub-surface Communications: One underwater telephone (TSM 5110), 8.08 kHz, 100 W, CW, operates off both main batteries and emergency power.

Sonars: Scanning sonar (WESMAR SS 140 S) 150 Hz, 1600 ft (500 m) range, 360 degrees scan, CRT display, beam with seven degrees, transducer tilt adjustable from the horizontal four degrees upward to 90 degrees downward.

Echo Sounder: (KODEN Mod. 385 A) 75 Hz, three transducers, strip chart recorder.

Jettisonable Components: Security weight 100 kg (220 lbs), batteries pods, 170 kg (375 lbs) in water.

Emergency Breathing: Two (FENZY Mfg) providing four hours for each occupant.

Communications Procedure: Check with surface every 10 min., abort dive if no contact with 30 min.

System Readiness: Operational.

Classification/Certification: ABS.

Support Ship: NA.

Owner: COMEX

13275 Marseille CEDEX 2

France

Builder: Same as above.

Operator: Same as above.

Point-of-Contact: J.L. Somnier and/or J. Massol

C/o COMEX Services

(Address same as above)

Telephone: (91) 41.01.70 Marseille

Telex: 410985 F

GRIFFON

CHARACTERISTICS

Length.....7.8m (25.6 ft)	Hatch Diameter.....80cm (31 in.)
Beam.....2.3m (7.5 ft)	Life Support Duration....120 man hrs
Height.....3.1m (10.2 ft)	Total Power.....26 kWh
Draft.....2.1m (6.9 ft)	Speed: Cruise (kts/hrs)..2/8
Weight (dry)....12.5t (13.7 tons)	Max (kts/hrs)....4/4
Operating Depth..600m (1,969 ft)	Crew: Pilot(s).....2
Collapse Depth...900m (2,953 ft)	Observer(s).....1
Launch Date.....1973	Payload.....350kg (973 lbs)
	Color.....Yellow

Pressure Hull: Cylindrical shape, hemispherical end cap forward, cone aft. Composed of steel 12-14mm (0.3-0.6 in.) thick and OD of 1.6m (5.2 ft).

Power Source: All power (main and emergency) from nickel cadmium batteries. Main battery supply is two banks of 192 cells each supplying 220 VDC of 104 amp-hr capacity. Main batteries are pressure compensated. Auxiliary and emergency batteries are inside hull and supply 28 VDC.

Maneuvering Control: Static: Four MBTs of 2.4m³ (85 ft³) capacity total. Two VBTs can change + buoyancy by 150 l. (159 qts) each. Dynamic: One, two-speed, stern-mounted, reversible, fixed, screw-type propeller aft of five hp. Two vertical (p/s amidships) thrusters and one lateral (forward) thruster all of 0.5 hp each and all reversible, screw-type.

Pitch/Trim: Transfer of fresh water forward or aft can produce up/down bow angle of + seven degrees.

Life Support: Six O₂ flasks of ten l. (10.6qts) capacity each are carried externally at 170 bars (2,465 psi). CO₂ is removed by scrubbing through IR8 (soda lime) of which 64kg (141 lbs) are carried. There is an emergency power supply in hull for the scrubber. O₂, CO₂, temperature, humidity and pressure are monitored at opportune periods.

Viewing: Five viewports total, four are in the bow and one is in the conning tower looking forward. Two TV cameras are carried, one monitors forward viewing and another monitors the after area, both are fixed and both have video recorders.

Manipulator: One, 2m (6.6 ft) max. length, electrically-powered, six degrees-of-freedom, parallel jaws-type claw, can lift 15kg (33 lbs) at max. extension and 150kg (331 lbs) in maximum lift position. Max. jaw opening 170mm (6.6 in.), jettisonable.

Lift Points: Two, topside and aft of conning tower. Each consists of an oval-shaped, 7.5cm (3 in.) thick, steel plate which rotates fwd/aft on a steel pin. The attachment point in each plate is a circular hole 60mm (2.4 in.) diameter.

External Lighting: Total lights four, all quartz iodide and 750 w. Three look forward into viewing area; one looks aft to illuminate TV viewing area. French Navy (CERTSM) Mfg.

Surface Lights: One, flashing white, one sec rep. rate, 80cm (32 in.) above surface, operates off emergency battery.

Anchor: A lead clump (jettisonable) of 200kg (442 lbs) weight can be lowered or raised on 20m (66 ft) of cable to act as an anchor.

Fire Extinguishers: Two, distilled water, eight l. (8.4 qts) capacity each.

Emergency Food & Water: Eight liters (8.4 qts) of water taken on each dive. Special life raft type rations are carried in air and water-tight packages.

Medical Supplies: First aid kit.

Surface Communications: One, five channel UHF, 27 MHz, operating off the auxiliary or the emergency (in-hull) battery.

Sub-Surface Communications: One (Straza ATM 504A TIPE Option) operating on 8.0875 kHz with CW.

Sonars: CTFM Sonar (Amtek Straza Mod. 5001B), 360 degree scan. Pinger: One, 14.5 kHz, 3 to 60 sec. rep. rate. Echo Sounder: Downward looking, 14.5 kHz.

Transponders: Two, one responds to and transmits on 25 kHz. The second is interrogated on eight kHz and responds at seven kHz with a three/60 sec. rep. rate.

Marker Buoy: One, attached to after lift point, consists of pressure-resistant cylinder, international orange, 80cm (31 in.) length, 40cm (16 in.) diam. and attached by 800m (2,624 ft) of 4mm (0.15 in.) diam. line to a 2m (6.6 ft) long, 15t (18.4 tons) lift capacity cable. The buoy end of the steel cable is configured to accept a retrieving line which can be slid down the nylon line. Lift capacity of buoy is from 10kg (22 lbs) at operational depth, to 40kg (88 lbs) at surface.

Jettisonable Components: Weight - 182kg (401 lbs), manipulator - 239kg (527 lbs), Batteries - 700kg (1,545 lbs), VBT blow - 150kg (331 lbs).

Emergency Breathing: Three, (Fenzy Mfg.), closed-circuit, six hrs duration each.

Communications Procedure: Check with surface every 30 minutes; abort dive if no contact after 45 minutes.

System Readiness: Operational

Classification/Certification: According to French Naval standards

Support Ship: COMMANDANT ROBERT GIRAUD

Owner: French Navy

Operator: Commandant la Division
des Sous-Marins d'Intervention et du Bathyscaphe
du GISMER
83 800 TOULON NAVAL
France

Builder: Same as above

Point-of-Contact: Capitaine de Corvette
(Address same as operator)
Telephone: (94) 926300 (Toulon)

HAKUYO

CHARACTERISTICS

Length.....21 ft (6.4m)	Hatch Diameter.....18 in. (46cm)
Beam.....5.2 ft (1.6m)	Life Support Duration.....156 man hrs
Height.....9.5 ft (2.9m)	Total Power.....14.4 kWh
Draft.....6.2 ft (1.9m)	Speed: Cruise (kts/hrs)..1/5
Weight (dry)....7.2 tons (6.6t)	Max (kts/hrs).....3.5/1
Operating Depth..984 ft (300m)	Crew: Pilot(s).....2
Collapse Depth...1969 ft (600m)	Observer(s).....1
Launch Date.....1971	Payload.....331 lbs (150kg)
	Color.....Conning tower red; remainder white

Pressure Hull: Steel cylinder with hemispherical end caps, 4.6 ft (1.4m) OD, 12 ft (3.67m) long and 0.47 in. (12mm) to 0.55 in. (14mm) thick in cylinder and end caps, respectively.

Power Source: Lead acid batteries in a pressure-resistant pod delivering 120 V x 100 amp-hr (for six hrs) and 24 V x 100 amp-hr (for six hrs).

Maneuvering Control: Main propulsion (fwd/rev) is provided by a stern-mounted, ten hp, trainable (90 degrees left/right) propeller. Two vertical thrusters, 0.5 hp (fwd/aft); one lateral thruster 0.5 hp (fwd). Static vertical motion derived by two auxiliary VBTs of 9.3 gal (35 l.) and 10.3 gal (39 l.) capacity and one negative tank of 17 gal (65 l.) capacity. VBTs can be blown or pumped dry at operating depth.

Pitch/Trim: Bow angles of +20 degrees can be obtained by movement of a 253 lb (115kg) weight forward or aft.

Life Support: Thirteen gal (50 l.) of O₂ carried externally. CO₂ removed by baralyme. Monitors for O₂, CO₂ and temperature.

Viewing: A total of 14 viewports 5.9 in. (15cm) ID are located in the bow (8 ea) and in the conning tower (six ea).

Manipulator: One jettisonable manipulator, five degrees-of-freedom, 3.9 ft (1.2m) max. extension, maximum lift of 22 lbs (10kg), parallel jaws type claw with maximum opening of 3.9 in. (10cm).

Lift Points: Main lift point is a specially constructed housing of 23.2 tons (21t) capacity into which a custom made lift device is inserted. Four lift padeyes of 2 in. (5cm) diam. are located topside with a lift capacity of 6.1 tons (5.5t) each.

External Lighting: Three, 1,000 w, incandescent lights (AMF design) are situated on the bow.

Life Jackets: Three, inflatable

Surface Lights: Xenon flashing light 2.5 ft (0.75m) above the water, 48 hrs duration, self-powered, rep. rate: 1/sec.

Fire Extinguisher: One, dry chemical

Surface Communications: CB radio, 27 MHz, 0.1 w, self-powered.

Sub-Surface Communications: One underwater telephone, 8 kHz, powered off either main or emergency batteries. Communications check with surface every 20 minutes, abort dive if no contact within 40 minutes.

Sonars: Obstacle avoidance sonar consists of three bow-mounted, 200 kHz transducers, separated to scan a 60 degree forward cone. Transponder (AMF model) of 10 kHz transmit/receive frequency, self-powered.

Jettisonable Components: Battery pod manually jettisonable to obtain 276 lbs (250kg) positive buoyancy. Manipulator jettisonable. Auxiliary and negative VBTs can be blown or manually pumped dry at operating depth, max. positive buoyancy attainable: 2,336 lbs (1,058kg).

Emergency Breathing: Three scuba regulators draw off flasks of compressed air inside hull providing three hours for each occupant.

System Readiness: Operational

Classification/Certification: Constructed in accordance with Ministry of Transport guidelines.

Support Ship: NEREUS

Owner: Ocean Systems Japan, Ltd.
6-1, Nishishinjuku 2-chome Shinjukuku
Tokyo 160
Japan

Operator: Same as above

Builder: Kawasaki Heavy Industries, Ltd.
2-14 Higashikawasaki-cho
Jyogo-Ku
Kobe 650
Japan

Point-of-Contact: Same as operator
Telephone: 03-344-6401
Cable: Telex No. J26762

JIM

CHARACTERISTICS

Height.....	6.5 ft (2.0m)	Life Support.....	20 man hrs
Width (front).....	3.4 ft (1.0m)	Total Power.....	Manual
Width (side).....	3.1 ft (0.9m)	Crew: Operator.....	1
Weight (dry & empty).....	910 lbs (413kg)	Payload.....	Various to accommodate operator's weight
Weight (dry with operator).....	1,100 lbs (499kg)	Color.....	White
Operating Depth.....	1,500 ft (457m)		
Launch Date.....	1973 (1st unit)		

Pressure Hull: Human configuration. Main body and dome, knee spacer and boots are composed of magnesium alloy. Joints, elbow spacers and hand enclosures composed of an aluminum alloy which are fluid-supported at a pressure in excess of ambient water pressure.

Power Source: Manual

Maneuvering Control: JIM is lowered and raised to the work site by a lift cable. On site the operator is capable of maneuvering as would a human on the surface. The underwater weight can be varied to meet varying conditions.

Life Support: O₂ is carried externally in two flasks of 800 l. (846 qts) total capacity and is bled continuously into the suit. The operator inhales normally and exhales through an oral/nasal breathing mask. A one-atmosphere pressure is automatically maintained by a control valve which supplies O₂ at the rate required to maintain desired pressure. CO₂ is removed by scrubbing (two units) through soda lime. Monitors for O₂, pressure and temperature (inside suit and on surface).

Viewing: Four acrylic plastic viewports in the dome, two look forward obliquely upward and downward; two look obliquely downward and are located to the left and right of the forward-looking viewports. Two smaller viewports in back of dome for rear viewing.

Manipulators: Two arms capable of human arm movement, but restricted to an angular movement of 40 degrees. The arms are an integral part of the pressure suit. The fingers or claws are pincer-type with machined channels to allow various grasping capabilities.

Lift Point: Always operates with lift line attached.

Lighting: NA

Sub-Surface Communications: Hard-wire telephone to surface support craft. Communication line is left open during dive and provides virtually continuous surface-to-diver monitoring.

Jettisonable Components: Cable and ballast weights manually jettisonable. Suit will surface when ballast weights are released.

System Readiness: JIM 1 - Display, not operational
 JIM 2 & 3 - Operational, in U.K.
 JIM 4 - Operational, in Washington, D.C. for U.S.N. evaluation
 JIM 5 & 7 - Operational, in U.K.
 JIM 6 & 8 - Operational, in Australia
 JIM 9-13 - Under construction

Classification/Certification: Lloyds Register of Shipping

Support Ship: Ship of Opportunity

Owner: DHB Construction Ltd.

Operator: DHB Construction Td.

Alton, England

and

Oceaneering International

Santa Barbara, Ca.

Builder: Underwater Marine Equipment Ltd.

Farnborough, Hants

England

Point-of-Contact: Mr. Donald Sites

Oceaneering International Ind.

414 East Cota

Santa Barbara, Ca. 93101

Telephone: (805) 963-6526

Telex: 687472 Oceaneering SNC

Cable: OCEANEERING

JOHNSON-SEA-LINK I

CHARACTERISTICS

Length.....	22.8 ft (6.9m)	Hatch Diameter.....	18 in. (46cm) (Pilot)
Beam.....	7.9 ft (2.4m)	Life Support Duration.....	27 in. (69cm) (LOC)
Height.....	10.6 ft (3.2m)	Total Power.....	480 man hrs
Draft.....	7.5 ft (2.3m)	Speed: Cruise (kts/hrs)...	32 kWh
Weight (dry).....	11 3/4 tons (10.7t)	Max (kts/hrs).....	0.75/6
Operating Depth...	3,000 ft (914m)	Crew: Pilot(s).....	1
Collapse Depth....	8,000 ft (2,348m)	Observer(s).....	3 (2 divers)
Launch Date.....	1971	Payload.....	1,000 lbs (453kg)
		Color.....	Aluminum

Pressure Hull: Two hulls: one sphere (fwd) and one cylinder (aft). Sphere: acrylic plastic, 66 in. (168cm) OD, 4 in. (10cm) thick. Cylinder: aluminum, 59.5 in. (151cm) OD, 8 ft (2.4m) long, 3.36 in. (8.5cm) thick.

Power Source: Fourteen, two VCD Exide DTSC-29 pressure-compensated, lead acid batteries rated at 1,190 amp-hrs. Two aircraft-type emergency batteries, each provides 20 amp-hr at 20 hr rate.

Maneuvering Control: Dynamic: eight, four-bladed propellers with kort nozzles, 1.25 hp reversible, two fwd. thrusters mounted aft, two fwd. thrusters mounted P/S amidships, two vertical thrusters mounted fwd/aft, two horizontal thrusters mounted fwd/aft. Static: Two VBTs 88 lbs (40kg) each. Two dive ballast tanks of 201 lbs. (91kg) capacity each. Two MBTs of 1,727 lbs (782kg) each.

Life Support: Two external O₂ tanks of 267 ft³ (7.6m³) capacity each at 2,400 psi (168kg/cm²). Three (one sphere, two cylinders) mixed gas cylinders of 1,769 ft³ (50.1m³) (sphere) and 614.5 ft³ (17.4m³) (cylinder) capacity each. CO₂ scrubber compound: LiOH, 50 lbs (23kg) spare carried in both compartments, 6 lbs (2.7kg) soda sorb used to perform routine mission. Two CO₂ monitors each in pilot's and diver's compartments. Two O₂ monitors in pilot's sphere, one in diver's compartment. Diver life support, when locked out, is from a KMB-10 open circuit mask or a Bio-Marine CCR-1000 which can also be used as backup CO₂ scrubber. Pilot's sphere contains a 0-10 FSW pressure sensor and an air conditioner. Protective clothing (thermal) carried.

Viewing: Pilot's sphere: Panoramic viewing. Dive cylinder: one viewport each side, one forward, one in both hatch covers.

Manipulator: One, six function, variable, rotatable grips (scissors, parallel jaws), 72 in. (183cm) maximum extension; 150 lbs (68kg) maximum weight lift at maximum extension. Not jettisonable. Tool function rotates compartmented collection basket.

Lift Point: A rectangular housing, 8.6 in. (21.8cm) x 8.6 in. x 16.9 in. (42cm) is situated topside, amidships. A torpedo-shaped device (Drop Lock) with four flukes fits into the housing and the flukes provide the lift point when tension is applied to the lift cable. To release the device, the cable is relaxed and high pressure air is blown into the housing by the pilot. The air blows the flukes back against the core and allows it to be pulled free by the surface.

External Lighting: Four lights total, all incandescent (Birns & Sawyer Mod. 5535) two are mounted forward (p/s) on both ballast tanks (350 w). One xenon short arc light.

Life Jackets: Four, inflatable.

Distress Flares: Six, red, fired through pilot's hatch cover.

Surface Lights: White, flashing xenon light, self-powered, with a duration of 40 hrs and a flash of 1.2 watt-seconds intensity every two seconds. Height above surface about 1 ft (0.3m).

Fire Extinguisher: One, dry chemical, in each compartment.

Emergency Food & Water: Two gal (7.5 l.) of water and two sea water desalinization kits in each compartment. Emergency food: raisins, Hershey Bars, canned nuts, fruit juice.

Medical Supplies: First aid kit in both compartments

Surface Communications: Primary: FM transceiver (Motorola Mocom 35), 15 w output and two frequencies, one for sub-to-ship and one for Coast Guard (156.8 MHz).

Secondary: FM transceiver (Motorola Handie-Talkie), five w output, self-powered with eight hrs duration at five % transmit, five % receive and 90% standby. Frequencies of secondary same as primary.

Sub-Surface Communications: Sub-to-ship: Underwater telephone (Ametek/Straza Mod. Atm-504A) frequency 8.087 kHz, CW, 20,000 yds (18,288m) max range. This model can also act as a transponder (transmit 9.337 kHz), a pinger (transmit 14.5 kHz) and an echo sounder (transmit; receive at 14.5 kHz). Sub-to-diver: 1) Underwater telephone (Helle Intercom), 300-1,200 Hz, with speaker/microphone in both pilot sphere and LOC. 2) One-way communication (sub-to-diver) is provided by an external speaker and amplifier transmitting on 200 to 5,000 Hz. Inter compartment: A sound-powered phone provides voice communication between the pilot's sphere and LOC.

Sonars: Scanning sonar (Straza Model 500 CTFM), transmits from 87-72 kHz, scans 360 degrees at ranges from 3 yds (3.7m) to 1,500 yds (1372m). Transponder interrogating at 82-87 kHz, receiving at 40 to 55 kHz. Displays visually and aurally. Pingers: Two, one (Ametek Straza Mod. 7050A) is self-powered, 25 day duration, dual frequency (9 & 45 kHz), salt water-activated, rep. rate of 1.5 sec. The second (Helle Mod. 2460) is powered by the submersible's battery, is pilot-activated and transmits at 37 kHz once/second, duration considered indefinite. Transponders: One (Vicker's model) receiving at 39 kHz replying at 178 kHz, powered by submersible's batteries.

Marker Buoys: A 4.4 ft³ (0.12m³) spherical, fluorescent pink, polyfoam, inflatable buoy containing one quart of mineral oil is held within an aluminum tunnel behind the pilot's sphere (starboard). High pressure air is introduced by the pilot and the buoy expands and floats to the surface with 281 lbs (127kg) positive buoyancy. The buoy unreels 2,000 ft (610m) of 3/16 in. (0.5cm) diam. Phillystran line as it ascends. A specially designed drop lock can be slid down the cable to engage with a lift housing for retrieval.

Jettisonable Components: Battery pod jettisonable - 2,178 lbs (987kg). VBTs and MBTs can be blown at operating depth 3,455 lbs (1,565kg).

Emergency Breathing: Compressed air (from MBT) or mixed gas can be used in pilot's sphere and LOC by use of emergency breathing regulators (two each with facemasks in each compartment).

Egress Procedures: Pilot and observer can enter dive compartment and bring vehicle to surface.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: R/V JOHNSON

Owner: Harbor Branch Foundation, Inc.

Rt. #1, Box 196

Ft. Pierce, Florida 33450

Operator: Same as above

Builder: Same as above

Point-of-Contact: Mr. Roger W. Cook

Harbor Branch Foundation, Inc.

(Address same as above)

Telephone: (305) 465-2400

JOHNSON-SEA-LINK II

CHARACTERISTICS

Length.....	22.8 ft (6.9m)	Hatch Diameter.....	18 in. (46cm) (Pilot) 27 in. (69cm) (LOC)
Beam.....	7.9 ft (2.4m)	Life Support Duration.....	480 man hrs
Height.....	10.6 ft (3.2m)	Total Power.....	32 kWh
Draft.....	7.5 ft (2.3m)	Speed: Cruise (kts/hrs)...	0.75/6
Weight (dry).....	11 3/4 tons (10.7t)	Max (kts/hrs).....	1.25/NA
Operating Depth...	3,000 ft (914m)	Crew: Pilot(s).....	1
Collapse Depth....	6,000 ft (1,829m)	Observer(s).....	3 (2 divers)
Certification		Payload.....	1,000 lbs (453kg)
Date.....	Nov 1975	Color.....	Aluminum

Pressure Hull: Two hulls: one sphere (fwd) and one cylinder (aft). Sphere: acrylic plastic 66 in. (168cm) OD, 4 in. (10cm) thick. Cylinder: Aluminum, 59.5 in. (151cm) OD, 8 ft (2.4m) long, 3.36 in. (8.5cm) thick.

Power Source: Fourteen, two VDC, Exide DTSC-29, pressure compensated, lead acid batteries rated at 1,190 amp-hrs at six hr rate. Two aircraft-type emergency batteries each provides 24 amp-hr at 20 hr rate.

Maneuvering Control: Dynamic: eight, four-bladed propellers with kort nozzles, 1.25 hp reversible, two fwd thrusters mounted aft, two fwd thrusters mounted P/S amidships, two vertical thrusters mounted fwd/aft, two horizontal thrusters mounted fwd/aft. Static: Four VBTs 88 lbs (40kg) each. Two dive ballast tanks of 201 lbs (91kg) capacity each. Two MBTs of 1,727 lbs (782kg) each.

Life Support: Two external O₂ tanks of 330 ft³ (9.4m³) capacity each at 2,600 psi (182kg/cm²). Six (one sphere, five cylinders) mixed gas cylinders of 1,769 ft³ (50m³) (sphere) and 1,425 ft³ (100m³) (cylinders) capacity each at 2,600 psi. CO₂ scrubber compound: LiOH, 50 lbs (23kg) spare carried in both compartments, 6 lbs (2.7kg) soda sorb to perform routine mission. Two CO₂ monitors each in pilot's sphere and LOC. Two O₂ monitors in pilot's sphere, one in LOC. Diver life support, when locked out, is from a KMB-10 open circuit mask or a Bio-Marine CCR-1000 which can also be used as backup CO₂ scrubber, emergency life support is built into this system. Pilot's sphere contains a 0-10 FSW pressure sensor and an air conditioner. Protective clothing carried.

Viewing: Pilot's sphere: panoramic viewing. LOC: one viewport each side, one forward, one in both hatch covers.

Manipulator: One, six function, variable, rotatable grips (scissors, parallel jaws), 108 in. (274cm) maximum extension. Not jettisonable. Tool function rotates compartmented collection basket.

Lift Point: A rectangular housing, 8.6 in. (21.8cm) x 8.6 in. x 16.9 in. (43cm) is situated topside, amidships. A torpedo-shaped device (Drop Lock) with four flukes fits into the housing and the flukes provide the lift point when tension is applied to the lift cable. To release the device, the cable is relaxed and high pressure air is blown into the housing by the pilot. The air blows the flukes back against the core and allows it to be pulled free.

External Lighting: Four lights total, all incandescent (Birns & Sawyer Mod. 5535) two are mounted forward (p/s) on both ballast tanks (350 w). One (250 w) is mounted on a vertically-rotating plate just forward of the pilot's sphere. One xenon short arc light.

Life Jackets: Four, inflatable.

Distress Flares: Six, red, fired through pilot's hatch cover.

Surface Lights: White, flashing xenon light, self-powered, with a duration of 40 hrs and a flash of 1.2 watt-seconds intensity every two seconds. Height above surface about 1 ft (0.3m).

Fire Extinguisher: One, dry chemical in each compartment.

Emergency Food & Water: Two gal (7.5 l.) of water and two sea water desalinization kits in each compartment. Emergency food: raisins, Hershey Bars, canned nuts, fruit juice.

Medical Supplies: First aid kit in both compartments

Surface Communications: Primary: FM transceiver (Motorola D-43-DEN), 15 w output and two frequencies, one for sub-to-ship and one for Coast Guard (156.8 MHz).

Secondary: FM transceiver (Motorola Handi-Talkie), 5 w output, self-powered with eight hrs duration at five % transmit, five % receive and 90% standby. Frequencies of secondary same as primary.

Sub-Surface Communications: Sub-to-ship: Underwater telephone (Ametek/Straza Mod. Atm-504A), frequency 8.087 kHz, CW, 20,000 yds (18,288m) max range. This model can also act as a transponder (transmit 9.337 kHz; receive 10.087 kHz), a transponder interrogator (transmit 10.087 kHz, receive 9.337 kHz), a pinger (transmit 14.5 kHz) and an echo sounder (transmit; receive at 14.5 kHz). Sub-to-diver: 1) underwater telephone (Helle Intercom), 300-1,200 Hz, with speaker/microphone in both pilot's sphere and LOC. 2) One-way communication (sub-to-diver) is provided by an external speaker and amplifier transmitting on 200 to 5,000 Hz. Inter compartment: A sound-powered phone provides voice communication between the pilot's sphere and dive compartment.

Sonars: Scanning sonar (Straza Model 500 CTFM), transmits from 87 to 72 kHz, scans 360 degrees at ranges from 3 yds (3.7m) to 1,500 yds (1372m). Transponder interrogating at 82-87 kHz, receiving at 40 to 55 kHz. Displays visually and aurally. Pingers: Two, one (Ametek Straza Mod. 7050A) is self-powered, 25 day duration, dual frequency (9 & 45 kHz), salt water-activated, rep rate of 1.5 sec. The second (Helle Mod. 2460) is powered by the submersible's battery, is pilot-activated and transmits at 37 kHz once every second, duration considered indefinite. Transponders: One (Vicker's model) receiving at 39 kHz replying at 178 kHz, powered by submersible's batteries.

Marker Buoys: A 4.4 ft³ (0.12m³) spherical, fluorescent pink, polyfoam inflatable buoy containing one quart of mineral oil is held within an aluminum tunnel behind the pilot's sphere (starboard). High pressure air is introduced by the pilot and the buoy expands and floats to the surface with 281 lbs (127kg) positive buoyancy. The buoy unreels 2,000 ft (610m) of 3/16 in. (0.5cm) diam. Phillystran line as it ascends. A specially designed drop lock can be slid down the cable on 1,500 ft (457m) of cable to engage with a lift housing for retrieval of the submersible.

Jettisonable Components: Battery pod, jettisonable - 2,178 lbs (987kg). VBTs and MBTs can be blown at operating depth 3,455 lbs (1,565kg).

Emergency Breathing: Compressed air (from MBT) or mixed gas can be used in pilot's and diver's compartments by use of emergency breathing regulators (two each with facemasks in each compartment).

Egress Procedure: Pilot and observer can enter dive compartment and bring vehicle to surface.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: SEA DIVER

Owner: Harbor Branch Foundation, Inc.

Rt. #1, Box 196

Ft. Pierce, Florida 33450

Operator: Same as above

Builder: Same as above

Point-of-Contact: Mr. Roger W. Cook

(Address same as above)

Telephone: (305) 465-2400

LEO I

CHARACTERISTICS

Length.....	20 ft (6.1m)	Hatch Diameter.....	19.4 in. (49.5cm)
Beam.....	10 ft (3.1m)	Life Support Duration.....	336 man hrs
Height.....	12 ft (3.7m)	Total Power.....	40.8 kWh
Draft.....	8.75 ft (2.67m)	Speed: Cruise (kts/hrs)...	NA
Weight (dry).....	11.5 tons (10.4t)	Max (kts/hrs).....	2/NA
Operating Depth.....	2,000 ft (610m)	Crew: Pilot(s).....	1
Collapse Depth.....	4,200 ft (1,280m)	Observer(s).....	1
Launch Date.....	1976	Payload.....	1,700 lbs (771kg)
		Color.....	White, red sail

Pressure Hull: Spherical shape 80 in. (203cm) OD and 1.0 in. (2.54cm) thick composed of A516 Grade 70 steel.

Power Source: Lead acid batteries, pressure-compensated provide 120 VDC for 310 amp-hrs and 24 VDC for 100 amp-hrs.

Maneuvering Control: Two reversible, five hp (each) thrusters mounted p/s amidships can be rotated 120 degrees in the vertical plane to provide horizontal or vertical thrust.

Pitch/Trim: Sea water may be pumped from an aft sphere to a tank in the pressure hull to provide approximately ± 20 degrees bow angle. Approximately 400 lbs (180kg) of water is normally carried in the tanks. Lead trays carrying up to 900 lbs (408kg) of lead can be adjusted to varying payload conditions.

Life Support: O₂ is carried inside and outside of the pressure hull and totals 324 SCF (9.1m³). CO₂ is removed by LiOH. Monitors for O₂, CO₂, temperature, humidity and pressure.

Viewing: Plastic bow dome 4 in. (10.2cm) thick and 33 in. (84cm) outside radius.

Manipulator: One, hydraulically-powered, six degrees-of-freedom, scissors type claw, 66 in. (168cm) total length, 240 lbs (104kg) lift capacity at full extension. Claw jettisonable.

Lift Point: Single point lift; with patented location device.

External Lighting: Two, 1,000 w each quartz iodide lights mounted on the bow.

Life Jackets: Three, inflatable.

Surface Lights: One, flashing white.

Fire Extinguishers: One, dry chemical.

Medical Supplies: First aid kit.

Emergency Food and Water: Life boat type provisions and water.

Surface Communications: One VHF transceiver.

Sub-Surface Communications: One underwater telephone (Sub Comm Mfg.), 8 and 27 kHz, transducers on top and bottom of vehicle. Can be used as a pinger on 27 kHz.

Surface Homing Devices: Radio beacon.

Sonars: Scanning sonar (Wesmar SS140S), 160 kHz, 1,600 ft (488m) max. range, 360 degree scan, CRT display, transducer tiltable + four degrees to -90 degrees from the horizontal. Pinger mode in underwater telephone.

Directional Antennae: One hydrophone receiving on 27 kHz.

Jettisonable Components: Lead weight of 375 lbs (170kg) is manually jettisonable.

Thrusters and manipulator claws.

Emergency Breathing: Four closed-circuit (Drager Mfg.) devices, each provides 45 minutes breathing duration.

System Readiness: Operational

Classification/Certification: ABS

Support Ship SUBSEA II

Owner: P&O Subsea Ltd.

Sea Oil Support Base

Montrose

Angus

Scotland

Operator: Same as owner

Builder: International Hydrodynamics, Ltd.

Vancouver, B.C.

Canada

Point-of-Contact: Mr. R. Lloyd

General Manager

P&O Subsea Ltd.

(Address same as owner)

Telephone: Montrose 2883

Telex: 76301

LR2

CHARACTERISTICS

Length.....	24 ft (7.3m)	Hatch Diameter.....	18 in. (45.2cm)
Beam.....	10 ft (3m)	Life Support Duration.....	7 days
Height.....	8.5 ft (2.6m)	Total Power.....	63 KWH
Draft.....	7.25 ft (2.2m)	Speed: Cruise (kts/hrs)...	1 kt/8hr
Weight (dry).....	13 tons (11.8t)	Max (kts/hrs).....	2 kts/4hr
Operating Depth.....	1200 ft (366m)	Crew: Pilot(s).....	1
Collapse Depth.....	1300 ft (549m)	Observer(s).....	2
Launch Date.....	August 1975	Payload.....	1200 lbs (544kg)
		Color.....	White/Dayglo orange

Pressure Hull: Cylindrical shape, composed of Glass Reinforced Plastic (GRP) 55 in. (140cm) OD, 51 in. (130cm) ID, 141 in. (358cm) long.

Power Source: Lead acid batteries carried within a pressure-resistant pod provide 24VDC at 438 amp-hrs and 120VDC at 438 amp-hrs. Emergency power is provided by 20 VDC at 20 amp-hr gel cells.

Maneuvering Control: Dynamic: 10 hp thrusters provide vertical and fore/aft propulsion; 5 hp thrusters (forward and aft) provide lateral movement. Static: four main ballast tanks of 1600 lbs (726kg) capacity each.

Trim/Pitch Control: Internal water ballast system of 300 lbs (136kg) capacity can obtain bow angles of ± 8 degrees.

Life Support: O₂ is carried in six flasks at 2200 psi (155kg/cm²) and 350 SCF (9.8m³) capacity each. CO₂ is removed by scrubbing through soda sorb (routine) and lithium hydroxide (emergency). O₂, CO₂, temperature, humidity and cabin pressure are monitored every 15 minutes.

Viewing: Bow dome, 40 in. (102cm) diameter acrylic conning tower with 8 in. (20.3cm) diameter view port. Trainable CCTV on bow.

Manipulators: Two, one is for grasping, the other for work. Grasping manipulator: 24 in. (61cm) extension, hydraulically-powered, three degrees of freedom, "C"-shaped claws when opened, 200 lbs (91kg) lift capacity, claws jettisonable. Work manipulator: 34 in. (213cm) extension, hydraulically-powered, six degrees-of-freedom, parallel jaws-type claw, 120 lbs (54kg) lift capacity, claw jettisonable.

Lift Points: Normal lift point is a Rams Horn-shaped HY-100 steel plate with a 2.5 in. (6.4cm) diameter, circular hole penetration. Two 5 in. (12.7cm) diameter lift rings are located port and starboard which have a wire rope connected from them to the Rams Horn for emergency retrieval.

External Lighting: Six lights total, five are mounted forward on the bow, one is mounted on the stern. All are quartz iodide and 1000 watts.

Life Jackets: Two, inflatable.

Fire Extinguishers: Three. Two Dupont "Fireater" Halon 1301 and one BCF in machinery compartment.

Emergency Food and Water: Seven days (for 3 occupants) duration. Fourteen Turblokken man day packs. Twenty one 14 oz. water cans. Two space blankets.

Medical Supplies: First aid kit.

Surface Communications: VHF (Dymar Princess), 20 watts, 157.65 MHZ (Channel 33) with emergency power. Line-of-sight to horizon.

Sonars: Wesmar SS140 scanning sonar, 160kHz, 30 to 360 degrees horizontal training.

Pinger: one, 27 kHz, Subcom Mfg. Transponder: one, 9-11 kHz, AMF Mfg.

Directional Antennae: One (Helle Mfg.), 27 kHz, fixed on bow.

Marker Buoy: One buoy on line which can be ejected.

Sub-Surface Communications: One (Subcom Mfg. model 200S-20B) 10 and 27 kHz.

Jettisonable Components: Manipulator claws, battery pods emergency buoy. Total weight 10,000 lbs (4,581kg). All released by a hydraulic hand pump.

Emergency Breathing: Four U.S. diver demand valves connected to high pressure air supply. Planned duration is 30 minutes each.

Communications Procedure: Surface check every 15 minutes. Dive is aborted after 30 minutes without establishing communications.

Classification/Certification: Lloyds Register of Shipping

Support Ship: VICKERS VISCOUNT

Sub Status: Operational

Owner: Vickers Oceanics Ltd.

Leith, Edinburgh

Scotland

Operator: Same as above

Builder: Vickers Slingsby

Kirbymoorside

Yorkshire

Point-of-Contact: Vickers Oceanics Ltd.

P.O. Box 215

Leith, Edinburgh

Scotland

Telephone: 031-554-4411

Telex: 72248

LR3

CHARACTERISTICS

Length.....	24 ft (7.3m)	Hatch Diameter.....	21 in. (53.3cm)
Beam.....	9.25 ft (2.8m)	Life Support Duration.....	576 man hrs.
Height.....	9 ft (2.7m)	Total Power.....	63 KWH
Draft.....	7.3 ft (2.2m)	Speed: Cruise (kts/hrs)...	1.2kts/5hrs
Weight (dry).....	14 tons (12.7t)	Max (kts/hrs).....	2kts/3.5hrs
Operating Depth.....	1500 ft (457m)	Crew: Pilot(s).....	1
Collapse Depth.....	NA	Observer(s).....	1/2
Launch Date.....	Dec 1976	Payload.....	1600 lbs (725.8kg)
		Color.....	White

Pressure Hull: Cylindrical shape, composed of Glass Reinforced Plastic (GRP), 57 in. (145cm) OD, 53 in. (135cm) ID, 141 in. (358cm) long.

Power Source: Lead acid batteries carried within pressure-resistant pods provide 24VDC at 438 amp-hrs and 120VDC at 438 amp-hrs at a 5 hour discharge rate. Emergency power of 24VDC at 20 amp-hrs is provided.

Maneuvering Control: Dynamic: one stern-mounted thruster trainable 90 degrees to port and to starboard, one horizontal bow thruster and two side thrusters. All thrusters are rated at 5hp. Static: four air ballast tanks of 1700 lbs (771kg) capacity and trim tanks of 595 lbs (270kg) capacity.

Trim/Pitch Control: Two sea water trim tanks and one moveable drop/trim weight provide ± 6 degrees (sea water) and ± 11 degrees (trim weight only) bow angle.

Life Support: Oxygen is carried externally, 635 SCF (18m³) capacity. CO₂ is removed by scrubbing through soda sorb (routine) or lithium hydroxide (emergency). O₂, CO₂, temperature and cabin pressure are monitored every 15 minutes.

Viewing: One 40 in. (102cm) diameter bow dome, plastic conning tower dome and a viewport in the hatch cover. TV camera mounted externally.

Manipulators: One, 6 ft. (1.8m) length, hydraulically powered, six degrees-of-freedom, scissor-type claw, 200 lbs (91kg) lift capacity, lower arm and claw jettisonable.

Lift Point: A "Rams Horn" shaped lift attachment with a 2.5 in. (6.4cm) diameter circular penetration is located just aft of the conning tower. Emergency lift rings of 5 in. (12.7cm) ID are also provided. Emergency lift lines run to each side of the vehicle. Lift capacity of Rams Horn and each lift line is 20 tons (18.1t).

External Lighting: Four quartz iodide lights, 1000 watts each. Three are located forward and 1 aft. A 500 watt thallium iodide light is mounted on the bow. All lights are manufactured by Photosub Ltd.

Life Jackets: Two, inflatable.

Surface Communications: VHF, Storno COM6R, 157.65, 156.80 and 156.65 MHZ.

Status: Operational

Classification/Certification: Lloyds Register of Shipping

Owner: Vickers Oceanics Ltd.

Old Dock

Leith, Edinburgh

Scotland

Operator: Same as above

Builder: Vickers Slingsby
Kirbymoorside, Yorkshire

Point-of-Contact: Vickers Oceanics Ltd.

P.O. Box 215

Leith, Edinburgh

Scotland

Telephone: 031-554-4411

Telex: 72248

MANTIS

CHARACTERISTICS

Length.....	2.05m (6.7 ft)	Hatch Diameter.....	NA
Beam.....	1.37m (4.5 ft)	Life Support Duration.....	40 man-hrs
Height.....	1.07m (3.5 ft)	Total Power.....	Indefinite (tethered)
Weight (Dry).....	1,100kg (2,205 lbs)	Speed: Max (kts/hrs).....	2/indefinite
Operating Depth.....	610m (2,000 ft)	Cruise (kts/hrs)...	0-2/indefinite
Collapse Depth.....	NA	Crew: Pilot(s).....	1
Launch Date.....	1978 (2 vehicles)	Observer(s).....	0
		Payload.....	200kg (440 lbs)
		Color.....	Black and Yellow

Pressure Hull: Cylindrical shape. Main body composed of filament wound resin impregnated tube.

Power Source: All electrical power is normally supplied from the surface through an armored umbilical cable. Emergency onboard batteries provide full thrust for 40 minutes if surface power fails.

Maneuvering Control: Eight thrusters. Four provide movement in the horizontal plane and four provide movement in the vertical plane. Thrusters are controlled either by hand or foot. Buoyancy can be controlled by "soft" tank compressed air system which provides 160 lbs (27kg) variation.

Life Support: Nominally 16 hours are provided by an automatic system. A total of 40 hours (nominally) is provided by an oral-nasal face mask. Partial pressure of O₂ is continuously monitored. Audio alarm system provides warning of high or low cabin pressure to the pilot and the surface.

Viewing: A 6.35cm (2.5 in.) thick acrylic plastic bow hemisphere provides panoramic viewing. CCTV is provided on pan/tilt device which can be monitored by the surface using the umbilical cable for transmission.

Manipulator(s): Two, five degrees-of-freedom, with lift capacity of 40kg (88 lbs) at full extension on bow. One, two degrees-of-freedom, with lift capacity of 130kg (287 lbs) located underneath vehicle.

Surface Communications: Hardwire communication through umbilical.

Sub-Surface Communications: Hardwire communication through umbilical. Provisions are made to install an acoustic, through-water communications systems to be used in the event of cable failure.

Sonar(s): Pinger for emergency location. Directional hydrophone system for pinger location/homing.

Jettisonable Components: Umbilical cable, emergency batteries, control pod, work frame, power pack, manipulators.

Emergency Breathing: Through oval-nasal mask.

System Readiness: Two systems are scheduled for completion by June 1978.

Classification/Certification: Lloyds Register of Shipping

Support Ship: Ship of Opportunity

Owner: Star Offshore Ltd.

London

England

Operator: Same as Owner

Builder: Same as Owner

Point-of-Contact: Mr. Graham Hawkes
OSEL Group
Bessemer Way
Harfreys Industrial Estate
Gt. Yarmouth, Norfolk NR30
England
Telephone: 55509
Telex: 976084

MARFAB (Name not yet determined)

CHARACTERISTICS

Length.....	15 ft (4.6m)	Hatch Diameter.....	18 in. (46cm)
Beam.....	3.5 ft (1.1m)	Life Support Duration.....	86 man-hrs
Height.....	6 ft (1.8m)	Total Power.....	11.7 kWh
Draft.....	3.3 ft (1 m)	Speed: Cruise (kts/hrs)...	2/NA
Weight (dry).....	4,900 lbs (2,222kg)	Max (kts/hrs).....	3.5/NA
Operating Depth.....	1,500 ft (457m)	Crew: Pilot(s).....	1
Collapse Depth.....	2,700 ft (823m)	Observer(s).....	1
Launch Date.....	late 1978	Payload.....	550 lbs (250kg) estimated
		Color.....	Yellow

Pressure Hull: Cylindrical shape, composed of A516 GR70 steel. Length 8 ft (2.4m), diameter 3.5 ft (1.1m), 0.5 in (1.27 cm).

Power Source: Lead acid batteries, 6V244 amp-hrs, contained in a sealed, pressure-resistant compartment integral to the pressure hull. Emergency power source not yet determined.

Maneuvering Control: One, trainable, 1.3hp propeller on the stern. Will include one variable ballast tank and dive plane.

Trim/Pitch Control: Lead weights will be manually shifted.

Life Support: Three, 52 ft³ (1.5m³) oxygen flasks, two carried inside hull, one carried externally. CO₂ will be removed by scrubbing cabin air through soda sorb. Monitoring devices for O₂, CO₂, temperature, humidity, pressure.

Viewing: Nineteen viewports. Nine in conning tower, ten in bow. Hand-held TV inside pressure hull.

Manipulators: One. Powered by human. Five degrees-of-freedom, 46 in. (117cm) long. Not jettisonable.

External Lighting: Nine, 150 watt, quartz iodide lights (MARFAB Mfg.) mounted at various locations.

Lift Point: Undetermined.

Life Jackets: Undetermined.

Fire Extinguisher: One, type undetermined.

Surface Communications: CB (5 watt).

Sub-Surface Communications: One underwater telephone, 8.087 kHz (27kHz option planned). One transducer mounted topside aft.

Sonar(s): CTFM (type undetermined) scanning sonar, 360 degree scan. Pinger, 37kHz, 0.5 second rep. rate (MARFAB Mfg.).

Jettisonable Components: Propeller and tail section, drop weight. Dimensions and weights undetermined.

Emergency Breathing: Undetermined.

Status: Under construction. Estimated completed by late 1978.

Classification/Certification: ABS

Support Ship: Undetermined.

Owner: MARFAB

1428 East Borchard
Santa Ana, CA 92705

Operator: Same as above

Builder: Same as above

Point-of-Contact: Mr. Douglas N. Privitt
MARFAB
1428 East Borchard
Santa Ana, CA 92705
Telephone: (714) 541-5035

MERMAID II

CHARACTERISTICS

Length.....	17.9 ft (5.5m)	Hatch Diameter.....	20.5 in. (52.1cm)
Beam.....	5.6 ft (1.7m)	Life Support Duration.....	240 man hrs
Height.....	8.5 ft (2.6m)	Total Power.....	18.5 kWh
Draft.....	5.9 ft (1.8m)	Speed: Cruise (kts/hrs)...	1.5/8
Weight (dry).....	6.55 tons (5,934kg)	Max (kts/hrs).....	3/NA
Operating Depth.....	1,000 ft (305m)	Crew: Pilot(s).....	1
Collapse Depth.....	1,920 ft (585m)	Observer(s).....	1
Launch Date.....	1972	Payload.....	1500 lbs (680kg)
		Color.....	White with orange MBTs

Pressure Hull: Cylindrical shape, high tensile steel (St53.7), 4.1 ft (1.25m) diam., 14.1 ft (4.3m) length, cylindrical conning tower and plastic bow dome.

Power Source: Lead acid batteries in pressure resistant pods, 56 V, 330 amp-hr.

Emergency power in hull, 40 amp-hr, 24 V, will power all electrical components except propulsion.

Maneuvering Control: Main propulsion: stern-mounted, reversible propeller 90 degrees trainable left/right, three hp. One lateral thruster, 1.6 hp, trainable 90 degrees in the horizontal (from p/s to fwd-aft) on the upper bow guard. Two vertical thrusters mounted p/s amidships.

Pitch/Trim: Batteries moved forward/aft in pod can provide +15 degrees bow angle.

Life Support: Four, external O₂ flasks. LiOH is used to remove CO₂. Monitors for O₂, CO₂, temperature, humidity and pressure. Drager hand analyzer used for backup O₂ but is primary means of CO₂ monitoring. CO₂ monitored every 30 minutes.

Viewing: Bow dome 36 in. (91cm) diam. TV camera with recorder on pan/tilt mechanism forward. Eight small viewports in conning tower; one is in hatch cover.

Manipulator: One, five degrees-of-freedom, hydraulically-activated, scissors claw. Linear extension. Total length 7 ft 10 in. (2.4m). Grasping capacity 100 lbs (45kg). Not jettisonable.

Lift Point: One, aft of sail. Opening is rectangular, 4.75 in. (12.1cm) wide, 12 in. (30.5cm) long, 3 in. (7.6cm) thick and trends athwartship.

External Lighting: Six lights total. Five are directed forward; three 75 w incandescent, one thallium iodide 50 w, two 70 w incandescent. One 75 w light mounted topside is directed towards the stern. Strobe lights (3 ea.).

Life Jackets: Two inflatable with closed-circuit breathing, (Drager Manuf.), 30 minutes each duration, mixed gas at 3,000 psi with soda sorb scrubber.

Surface Lights: One flashing, white light powered by normal or emergency system. Rep. rate is variable. Height about 3 ft (0.9m) above water.

Fire Extinguisher: One, dry chemical

Emergency Food & Water: Dry rations and two gals (2 l.) of water.

Medical Supplies: First aid kit

Surface Communications: CB, operates off normal and emergency power.

Sub-Surface Communications: Underwater telephone (Hydro Products Mod. DV812 and Mod. S812), 8.0875 kHz, CW. Operates off both normal and emergency power. Communications check every 15 minutes; if no contact in 30 minutes, dive is aborted.

Sonars: Scanning Sonar (Wesmar Mod. SS140S), 160 kHz, includes transponder interrogation. Pingers: Four total, two at 45 kHz, salt water activated (Johnson Laboratories, Mod. 38/330 and 38/331) 1 pulse/sec with CW capability; two are 37 kHz (Helle Mod. PC06). Two are mounted topside and two on keel. Keel pingers will be used as backup to locate submersible if lost in fog on the surface.

Marker Buoy: One, manually (hydraulically) released with 1,500 ft (457m) of line, orange color, football shape, 18 in. (46cm) length, 12 in. (30.5cm) width.

Jettisonable Components: Manually droppable weight 500 lbs (227kg). Air blow of MBTs.

Emergency Breathing: Closed-circuit breathing from two Drager units provide 30 minutes for each occupant. Scuba regulators (two each) draw off compressed air.

Egress Procedure: Flood hull and ascend to surface with Drager life jacket/closed-circuit breathing device.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: M/V ALOHA

Owner: IUC International Inc.

Apartado Postal 1450

Panama 1, Panama

Operator: International Underwater Contractors

P.O. Box 95

City Island, N.Y. 10464

Builder: Bruker-Physik AG

Karlsruhe, West Germany

Point-of-Contact: Mr. Booker T. Washington

264 Fordham Place

City Island, New York 10464

Telephone: (212) 885-0600

Cable: TECHDIVER

MERMAID III

CHARACTERISTICS

Length.....	7.2m (23.6 ft)	Hatch Diameter.....	60cm (23.6 in.)
Beam.....	3.0m (9.8 ft)	Life Support Duration.....	168 man hrs
Height.....	2.7m (8.8 ft)	Total Power.....	36 kWh
Draft.....	2.0m (6.6 ft)	Speed: Cruise (kts/hrs)...	1.5/7.5
Weight (dry).....	14.2t (15.7 tons)	Max (kts/hrs).....	2.8/2.5
Operating Depth.....	260m (853 ft)	Crew: Pilot(s).....	1
Collapse Depth.....	450m (1,476 ft)	Observer(s).....	1 + 2 divers
Launch Date.....	1975	Payload.....	150kg (331 lbs)
		Color.....	Sail and fairings are orange, remainder is light gray and white

Pressure Hull: Cylindrical shape with hemispherical end caps, composed of ST E 43 steel, ID 125cm (49.2 in.); length 630cm (248 in.).

Power Source: Lead acid batteries in two pressure-resistant pods, 56 cells, 330 amp-hr/cell, 110 V.

Maneuvering Control: Dynamic: Stern screw-type propeller, ten hp, reversible and trainable 90 degrees p/s. Two vertical (p/s) and two lateral (fwd/aft) thrusters of 1.5 hp each. Static: 390kg (860 lbs) hard ballast tanks.

Pitch/Trim: Batteries may be hydraulically shifted forward or aft to obtain a trimming moment of ± 160 mkp.

Life Support: O₂ and He carried externally. One CO₂ scrubber in pilot's sphere and LOC, scrubber in LOC is heated. Scrubbing compound if LiOH and soda sorb, emergency power for scrubber (24 V, 36 amp/hr). Monitoring devices for O₂ and CO₂.

Viewing: Plastic bow dome of 110cm (43.3 in.) diam., five 17cm (6.7 in.) diam. and two 8cm (3.1 in.) diam. viewports in conning tower. Four 17cm diam. viewports in LOC.

Lift Point: Main lift point aft of conning tower. It is fishhook-like in shape and inverted with the hook or barb side pointing aft. The hook is 10.1cm (4 in.) wide, 7.6cm (3 in.) thick and has a minimal opening of 7.6cm (3 in.). A safety bar is slid across the hook opening to secure the lift hauser in place.

External Lighting: Two, 30 w, quartz iodide lights on bow (Bruker Mfg.).

Surface Lights: One, 100 w, flashing light, white, 90cm (35 in.) above surface.

Fire Extinguisher: One, dry chemical.

Surface Communications: One, radio transceiver, 27 kHz.

Marker Buoys: One, manually (hydraulically) released on a cable of undetermined length. Orange color. Football shaped. Length 46cm (18 in.), width (diam. 30.5cm (12 in.)).

Jettisonable Components: Drop weight - 250kg (551 lbs). MBT blow - 390kg (860 lbs).

Emergency Breathing: Three, scuba regulators and mouthpieces draw off deballasting air. Duration depends on capacity of tanks, which is 100m³ (3,531 ft³) under normal operating conditions.

Egress Procedure: Pilot's compartment can be flooded to egress through conning tower hatch. Crew can enter diving (lockout) chamber, pressurize to ambient, and egress through lockout hatch.

System Readiness: Operational

Classification/Certification:

GERMANISCHER Lloyds

Support Ship: SUBSEA I

Owner: P&O Subsea Ltd.

Sea Oil Support Base

Montrose

Angus

Scotland

Operator: Same as owner

Builder: Bruker-Physik AG

D-7512 Karlsruhe - Rheinsteffen

Silverstreifen

W. Germany

Point-of-Contact: Mr. R. Lloyd

General Manager

P&O Subsea Ltd.

(Address same as owner)

Telephone: Montrose 2883

Telex: 76301

MERMAID IV

CHARACTERISTICS

Length.....	7.2m (23.6 ft)	Hatch Diameter.....	60 cm (23.6 in.)
Beam.....	1.8m (5.9 ft)	Life Support Duration.....	168 man hrs
Height.....	2.7m (8.8 ft)	Total Power.....	36 kWh
Draft.....	2.0m (6.6 ft)	Speed: Cruise (kts/hrs)...	1.5/7.5
Weight (dry).....	11.5t (12.7 tons)	Max (kts/hrs).....	2.8/2.5
Operating Depth.....	260m (853 ft)	Crew: Pilot(s).....	1
Collapse Depth.....	450m (1,476 ft)	Observer(s).....	1 + 2 divers
Launch Date.....	1976	Payload.....	150kg (331 lbs)
		Color.....	Sail and fairings are orange, remainder is light gray and white

Pressure Hull: Cylindrical shape with hemispherical end caps, composed of ST E 43 steel, ID 125cm (49.2 in.); length 630cm (248 in.).

Power Source: Lead acid batteries in two pressure-resistant pods, 56 cells, 330 amp-hr/cell, 110 V.

Maneuvering Control: Dynamic: Stern screw-type propeller, ten hp, reversible and trainable 90 degrees p/s. Two vertical (p/s) and two lateral (fwd/aft) thrusters of 1.5 hp each. Static: 299kg (660 lbs) Hard Ballast Tanks and anchor for lockout operations provide vertical movement.

Pitch/Trim: Batteries may be hydraulically shifted forward or aft to obtain a trimming moment of ± 160 mkp.

Life Support: O₂ and He carried externally. One CO₂ scrubber in pilot's sphere and LOC, scrubber in LOC is heated. Scrubbing compound is LiOH and soda sorb, emergency power for scrubber (24 V, 36 amp/hr). Monitoring devices for O₂ and CO₂.

Viewing: Plastic bow dome of 110cm (43.3 in.) diam., five 17cm (6.7 in.) diam. and two 8cm (3.1 in.) diam. viewports in conning tower. Four 17 cm diam. viewports in LOC.

Lift Point: Main lift point aft of conning tower. It is fishhook-like in shape and inverted with the hook or barb side pointing aft. The hook is 10.1cm (4 in.) wide, 7.6cm (3 in.) thick and has a minimal opening of 7.6cm (3 in.). A safety bar is slid across the hook opening to secure the lift hauser in place.

External Lighting: Two, 30 w, quartz iodide lights on bow (Bruker Mfg.).

Surface Lights: One, 100 w, flashing light, white, 90cm (35 in.) above surface.

Fire Extinguisher: One, dry chemical.

Surface Communications: One, radio transceiver, 27 kHz.

Marker Buoys: One, manually (hydraulically) released on a cable of undetermined length. Orange color. Football shaped. Length 46cm (18 in.), width (diam.) 30.5cm (12 in.).

Jettisonable Components: Drop weight - 250kg (551 lbs). MBT blow 299kg (660 lbs).

Emergency Breathing: Three, scuba regulators and mouthpieces draw off deballasting air. Duration depends on capacity of tanks, which is 100m³ (3,531 ft³) under normal operating conditions.

Egress Procedure: Pilot's compartment can be flooded to egress through conning tower hatch. Crew can enter diving (lockout) chamber, pressurize to ambient, and egress through lockout hatch.

System Readiness: Operational.

Classification/Certification:

Germanischer Lloyds

Support Ship: STAR PISCES

Owner: P&O Subsea Ltd.

Sea Oil Support Base

Montrose

Angus

Scotland

Operator: Same as owner.

Builder: Bruker-Physik AG

D-7512 Karlsruhe-Rheinstaffen

Silberstreifen

W. Germany

Point-of-Contact: Mr. R. Lloyd

General Manager

P&O Subsea Ltd.

(Address same as owner)

Telephone: Montrose 2883

Telex: 76301

MERMAID V

CHARACTERISTICS

Length.....	7.8m (25.6 ft)	Hatch Diameter.....	N/A
Beam.....	2.0m (6.6 ft)	Life Support Duration....	600 man hrs
Height.....	2.7m (6.9 ft)	Total Power.....	72 kWh
Weight (dry).....	14t (15.4 tons)	Speed: Cruise (kts/hrs).	1.5/7
Operating Depth.....	300m (984 ft)	Max (kts/hrs)....	2.5/NA
Launch Date.....	Construction	Crew: Pilot(s).....	1
		Observer(s).....	1
		Diver(s).....	N/A
		Payload.....	600kg (1,323 lbs)

Pressure Hull: Cylindrical shape, 1.25m (4.1 ft) diameter, steel.

Power Source: Lead-acid batteries in two pressure resistant pods. Auxiliary voltage: 24 V and 12 V. Emergency battery: 24 V at 36 amp-hrs.

Maneuvering Control: One stern-mounted, trainable main thruster, 10 hp. Four control thrusters, all are 1.5 hp. Two are for lateral propulsion and are mounted forward and aft. Two are for vertical propulsion and are mounted p/s amidships.

Life Support: Two oxygen flasks mounted external to pressure hull, each is 50 l (1.8 ft³) volume and is charged to 200 bars (2,900 psi). Mixed gas is carried externally in 10-50 l volume flasks at 200 bars.

Viewing: Acrylic plastic bow dome. Viewports girdle the conning tower. CCTV provided.

Manipulators: Will be provided.

Surface Communications: Will be provided.

Sub-Surface Communications: Will be provided.

Sonars: Echo sounder.

System Readiness: Under construction. Further details not available at this time.

Support Ship: N/A.

Owner: Bruker-Physik AG
 Silberstreifen
 7512 Karlsruhe-Rheinstetten
 West Germany
 Telephone: (0721) 51185
 Telex: (07) 826-836

Operator: Same as above.

Builder: Same as above.

Point-of-Contact: Mr. Jorg Haas
 7512 Karlsruhe-Rheinstetten
 West Germany

MERMAID VI

CHARACTERISTICS

Length.....	7.5m (24.6 ft)	Hatch Diameter.....	N/A
Beam	2.8m (9.2 ft)	Life Support Duration.....	900 man hrs
Height.....	2.5m (8.2 ft)	Total Power	70 kWh
Weight (dry).....	17t (18.3 tons)	Speed: Cruise (kts/hrs).....	N/A
Operating Depth.....	600m (1,969 ft)	Max (kts/hrs).....	3 kts/N/A
Lockout Depth	300m (984 ft)	Crew.....	N/A
Launch Date	Construction	Payload.....	1,000 kg

Pressure Hull: Steel, tri-spheres with lockout sphere (ambient-pressure and one-atmosphere transfer) and mating skirt in center.

Power Source: Lead-acid batteries in two pressure-resistant pods. Main battery: 120 VDC, 50-70 kWh. Auxillary battery: 24 and 12 VDC. Emergency battery: 12 VDC.

Life Support: All breathing gas containers are mounted external to the pressure hull.

The following breathing gasses and mixtures are carried: oxygen - 2 flasks, each 50 l (1.8 ft³) capacity, 300 bars (4,350 psi) pressure; mixed gas - 5 flasks, each 110 l (3,115 ft³) capacity, 300 bars pressure.

Viewing: Acrylic plastic bow dome; plastic, hemispherical dome acts as forward hatch cover. CCTV.

Manipulators: Will be provided.

Surface Communications: Will be provided.

Sub-Surface Communications: Will be provided.

Sonars: Pinger. Pinger locator. Echo sounder.

System Readiness: Under construction. Further details not available at this time. Vehicle is designed to serve for both diver lockout, dry transfer and rescue.

Classification/Certification: Germanischer Lloyds.

Support Ship: N/A.

Owner: Bruker-Physik AG
 Silberstreifen
 7512 Karlsruhe-Rheinstetten
 West Germany
 Telephone: (0721) 51185
 Telex: (07) 826836

Operator: Same as above.

Builder: Same as above.

Point-of-Contact: Mr. Jorg Haas
 7512 Karlsruhe-Rheinstetten
 West Germany

MOANA I

CHARACTERISTICS

Length.....	3.7m (12.2 ft)	Hatch Diameter.....	55cm (21.6 in.)
Beam.....	2.28m (7.5 ft)	Life Support Duration.....	288 man hrs
Height.....	2.62m (8.6 ft)	Total Power.....	32.4 kWh
Draft.....	2.20m (7.2 ft)	Speed: Cruise (kts/hrs)...	2/5
Weight (dry).....	7t (7.7 tons)	Max (kts/hrs).....	3.2/NA
Operating Depth.....	400m (1,312 ft)	Crew: Pilot(s).....	2
Collapse Depth.....	700m (2,296 ft)	Observer(s).....	1
Launch Date.....	1974	Payload.....	100kg (220 lbs)
		Color.....	Gray: framework & hull Orange & white: sail

Pressure Hull: Two steel spheres, ID 1.4m (4.6 ft) joined by a steel cylinder ID 55cm (18 in.) and 25cm (10 in.) length.

Power Source: Lead acid batteries in pressure-resistant cylinders. Batteries deliver 120 V at 270 amp-hr and 24 V at 65 amp-hr. Internal batteries for emergency power provide 24 V at 15 amp-hr.

Maneuvering Control: Eight, fixed, reversible screw-type propellers. Four provide main forward propulsion, two are vertical and two are lateral thrusters. All are 1.5 hp.

Pitch/Trim: Two hard tanks of 40 l. (10.6 gal) capacity each provide ± 15 degrees bow angle by differential filling of the tanks.

Life Support: O₂ is carried externally in two tanks of 25 l. (6.6 gal) capacity each at 200 bars (2,900 psi). CO₂ is removed by scrubbing through soda lime of which 70kg (154 lbs) is carried on each dive. The CO₂ scrubbers (one in each sphere) have emergency power inside the pressure hull. Monitors for O₂, CO₂, temperature, humidity and pressure which are checked every 15 minutes. Electric heaters are also carried.

Viewing: Nine viewports total. Eight of 55cm (21.6 in.) diam. each are in the forward sphere, five girdle the hull equator, one in the hatch, one looks up and forward, one looks down and forward. After sphere has one 30cm (11.8 in.) diam. viewport which looks directly aft. TV and recorder carried internally.

Manipulator: One, electrically-driven, six degrees-of-freedom, jettisonable, 1.8m (5.9 ft) long with parallel jaws-type claw. The manipulator can lift 35kg (72.2 lbs) at maximum extension; the claw can apply 150kg (331 lbs) of pressure.

Lift Points: A 1.25 in. (3.2cm) thick, 8.3cm (3.25 in.) ID shackle is mounted topside and aft of the hatch. A 3.2cm (1.25 in.) thick cable is attached to the shackle to form a loop approximately 0.9m (3 ft) long.

External Lighting: Eleven lights total, all quartz iodide and all 300 w each. Distribution is as follows: three forward, three starboard, three port and two are security lights illuminating lift attachment.

Life Jackets: Three, inflatable

Radar Reflector: One permanently mounted, 1.5m (4.9 ft), above water surface.

Surface Lights: One red and one green running light. One flashing, self-powered, white light, rep rate once every two seconds, 50cm (20 in.) above water surface.

Fire Extinguisher: One, dry chemical

Emergency Food and Water: Equal to life support duration.

Surface Communications: VHF, (Svenska Mod. ME-60) multi-channel transceiver, 25 w power. Emergency and identification communications on channel 16 (156-180 MHz), five channels for normal communications 10 km (5.4 nm) range.

Sub-Surface Communications: One underwater telephone (TSM 5110), 8.08 kHz, 100 w, CW, operates off both main batteries and emergency power.

Surface Homing Devices: Radio beacon, self-powered, pilot-activated, standard distress frequency (156.8 MHz). (A feature of the surface communications transceiver.)

Sonars: Scanning Sonar: (Wesmar SS140S) 160 kHz, 1,600 ft (488m) range, 360 degree scan, CRT display, beam width seven degrees, transducer tilt adjustable from the horizontal four degrees upward to 90 degrees downward. Echo Sounder: (Koden Mod. 385A) 75 kHz, three transducers (looking up, forward, down) maximum range: 300m (984 ft), strip chart recorder. Transponder: receives on 25 kHz, transmits on 50 kHz.

Marker Buoys: Three, two small and one large. Small buoys are ejected from the vehicle and consists of a small diameter nylon line, a three kg (6.6 lb) anchor weight and a 15cm (6 in.) diam. sphere. Large buoy is a rectangular block of syntactic foam 1.2m x 1.2m x 0.4m (3.9 ft x 3.9 ft x 1.3 ft), with 150 kg (331 lbs) lift, international orange with white stripes on edges, and is mechanically released. It is attached to vehicle by 400m (1,312 ft) of electrical cable which serves as a hardwire telephone.

Jettisonable Components: Security weight - 140kg (309 lbs), four propellers - 120kg (264 lbs), battery pods - 770kg (1,699 lbs), manipulator - 130kg (287 lbs). Total weight to provide 500kg (1,103 lbs) positive buoyancy.

Emergency Breathing: Three (Fenzy Mfg.), providing four hours for each occupant.

Communications Procedure: Check with surface every 15 minutes, abort dive if no contact within 30 minutes.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: NA

Owner: COMEX

13275 Marseille Cedex 2

France

Operator: Same as above

Builder: Same as above

Point-of-Contact: J. L. Somnier and/or J. Massol

c/o COMEX

Address same as above

Telephone: 40.11.70 Marseille

Telex: 410985 COMEX MARSL

MOANA III

CHARACTERISTICS

Length.....	4.5m (14.1 ft)	Hatch Diameter.....	55cm (21.6 in.)
Beam.....	2.45m (8.0 ft)	Life Support Duration.....	288 man hrs
Height.....	2.45m (8.0 ft)	Total Power.....	45.6 kWh
Draft.....	1.73m (5.7 ft)	Speed: Cruise (kts/hrs)...	1/12
Weight (dry).....	9t (9.9 tons)	Max (kts/hrs).....	2.5/3
Operating Depth.....	400m (1,312 ft)	Crew: Pilot(s).....	2
Collapse Depth.....	1200m (4,000 ft)	Observer(s).....	1
Launch Date.....	1976	Payload.....	362kg (800 lbs)
		Color.....	Gray: Framework White: Hull & sail

Pressure Hull: Two steel spheres 1.7m (5.6 ft) OD, 14mm (0.55 in.) thick, joined by a steel cylinder 73cm (28.7 in.) ID and 40cm (15.7 in.) long.

Power Source: Main power from lead acid batteries in pressure-resistant cylinders providing 120 V at 380 amp-hr and 24 V at 180 amp-hr. Emergency power inside pressure hull provides 24 V at 15 amp-hr.

Maneuvering Control: Eight, fixed, reversible, screw-type propellers. Four provide main forward propulsion, two are vertical and two are lateral thrusters. Six are 1.5 hp and two main forward propulsers are 3 hp.

Pitch/Trim: Battery shifting inside cylinders provide ± 30 degrees bow angle.

Life Support: O₂ is carried externally in two flasks, each have a volume of 25 l. (0.9 ft³) and are filled to 200 bars (2,900 psi) pressure. CO₂ is removed by two scrubbers filled with soda lime, 65.5kg (145 lbs) is carried. The scrubbers can operate off the main and emergency batteries. Monitors for O₂, CO₂, temperature, humidity and pressure which are checked every 15 minutes. Electrical heaters are included.

Viewing: Nine viewports total. Eight of 55cm (21.6 in.) diam. each are in the forward sphere, five girdle the hull equator, one is in the hatch, one looks up and forward, one looks down and forward. After sphere has a viewport of 69cm (27.2 in.) diam. in the hatch cover. TV and recorder carried internally.

Manipulator: One, electrically-driven, six degrees-of-freedom, jettisonable, 1.8m (5.9 ft) long with parallel jaws-type claw. The manipulator can lift 35kg (77.2 lbs) at maximum extension; the claw can apply 150kg (331 lbs) of pressure.

Lift Points: Circular-shaped, steel ring mounted topside, amidships, 28cm (11 in.) ID, 30t (33 tons) lift capacity.

External Lighting: Eleven lights total, all quartz iodide and all 300 w each. Three look forward, three starboard, three port and two are security lights for illuminating lift attachments.

Life Jackets: Three, inflatable

Distress Rockets: Two

Radar Reflector: One, permanently-mounted, diamond-shaped, 1.5m (4.9 ft) above water surface.

Surface Lights: One flashing white light, rep. rate once every two seconds.

Fire Extinguisher: One, dry chemical

Emergency Food and Water: Equal to life support duration

Surface Communications: VHF, (Svenska Mod. ME-60) multi-channel transceiver, 25 w power. Emergency and identification communications on channel 16 (156.80 MHz), five channels for normal communications 10 km (5.4 nm) range.

Sub-Surface Communications: One underwater telephone (TSM 5110), 8.083 kHz, 100 w power, CW, operates off main and emergency batteries.

Surface Homing Devices: Radio beacon, self-powered, pilot-activated, standard distress frequency (156.8 MHz). (A feature of the surface communications transceiver).

Sonars: Scanning Sonar: (Wesmar SS140S), 160 kHz, 1,600 ft (488m) range, 360 degree scan, CRT display, beam width seven degrees, transducer tilt adjustable from the horizontal four degrees upward to 90 degrees downward. Echo Sounder: (Koden Mod. 385A) 75 kHz, three transducers (looking up, forward, down), maximum range: 300m (984 ft), strip chart recorder.

Marker Buoys: Three, two small and one large. Small buoys are ejected from the vehicle and consist of a small diameter nylon line, a three kg (6.6 lbs) anchor weight and a 15cm (6 in.) diam. sphere. Large buoy is a rectangular block of syntactic foam 1.2m x 1.2m x 0.4m (3.9 ft x 3.9 ft x 1.3 ft), with 150kg (331 lbs) lift, international orange with white stripes on edges, and is mechanically released. It is attached to vehicle by 400m (1,312 ft) of electrical cable which serves as a hardwire telephone.

Jettisonable Components: Security weight - 400kg (883 lbs), four propellers - 120kg (265 lbs), manipulator - 130kg (287 lbs) and battery containers - 2,600kg (5,739 lbs).

Emergency Breathing: Three (Fenzy Mft.), providing four hours for each occupant.

Communications Procedure: Check with surface every 15 minutes, abort dive if no contact within 30 minutes.

System Readiness: Operational

Classification/Certification: ABS and Veritas

Support Ship: M/V PROTEE

Owner: COMEX

13275 Marseille Cedex 2

France

Operator: Same as above

Builder: Same as above

Point-of-Contact: J. L. Somnier and/or J. Massol

c/o COMEX

(address same as above)

Telephone: 40.11.75 Marseille

Telex: 410985 COMEX MARSL

MOB 501

CHARACTERISTICS

Length.....NA	Hatch Diameter.....23.6 in. (60cm)
Beam.....8.7 ft (2.7m)	Life Support Duration.....144 man hours
Height.....12.6 ft (3.9m)	Total Power.....180 KVA
Draft.....NA	Speed: Cruise (kts/hrs)....NA
Weight (dry).....10.5 tons (9.5t)	Max (kts/hrs).....2 kts
Operating Depth.....1,640 ft (500m)	Crew: Pilot(s).....1
Collapse Depth.....2,625 ft (800m)	Co-Pilot(s).....1
Launch Date.....1976	Payload.....882 lbs (400kg)
	Color.....White

Pressure Hull: One steel sphere - ID 7.2 ft (2.2m)

Power Source: Main: 440 VAC, 3 phases, 16 KW; Emergency: Internal batteries for emergency power provide 24 V - 270 Amp-hr.

Maneuvering Control: Eight, fixed, reversible screw-type propellers. Four provide main forward propulsion, two are vertical and two are lateral thrusters. All are 1.5 hp.

Pitch/Trim: Two hard tanks of 200 l. (422.7 pts) capacity each.

Life Support: O₂ is carried externally in three tanks of 20 l. (6.6 gal) capacity each at 200 bars (2900 PSI). CO₂ is removed by scrubbing through soda lime. The CO₂ scrubber has emergency power inside the pressure hull. Monitors for O₂, CO₂, temperature, humidity and pressure which are checked every 15 minutes. Electric heaters and dehumidifiers are also carried.

Viewing: Six flat viewports of 5.9 in. (15cm) diameter scheduled two 19.7 in. (50cm) girdle the hull equator. External TV with internal monitoring and recording.

Manipulator: One, hydraulically powered, six degrees-of-freedom. The manipulator can lift 441 lbs (200kg). One prehensile arm, two degrees-of-freedom.

Lift Points: Three cables are attached to the top with a shackle.

External Lighting: Eleven lights total, all quartz iodide, six 300 W each, two 500 W each, three emergency lights 150 W each. One flashing, self-powered, white light rep. rate once every ten seconds.

Surface Lights: One flashing, self-powered, white light, rep. rate once every two seconds.

Fire extinguisher: One dry chemical.

Emergency Food and Water: Equal to life support duration.

Surface Communications: Interphone. VHF (Svenska Mod ME 60) multi-channel transceiver, 25 W power. Five channels for communications, 10 Km (5.4m) range, operate off both main and emergency power.

Sub-Surface Communications: One underwater telephone (TSM 5110) 8.08 kHz, 100 W, CW, operates off both main and emergency power.

Surface Homing Devices: Optional, one transponder compatible with dynamic positioning 160hz system of mother ship.

Sonars: Scanning sonar, (WESMAR SS140S), 150 kHz, 1,600 ft (487.7m) range, 360 degree scan, CRT display, beam width seven degrees, transducer tilt adjustable from the horizontal four degrees upward to 90 degrees downward. Echo sounder (Koden Mod. 385A) 75 kHz, three transducers (looking up, forward, down). Max. range: 300 m (984 ft), strip chart recorder.

Jettisonable Components: Security weight - 882 lbs (400kg) - two manipulator arms - 485 lbs (220kg); Crock of the winch with its weight; Umbilical.

Emergency Breathing: Two Fenzy Mfg. providing four hours for each occupant.

Communication Procedure: Continuous, no set schedule.

System Readiness: Refit

Classification/Certification: ABS

Owner: COMEX

13275 Marseille, Cedex 2
France

Operator: COMEX

(Address same as above)

Builder: COMEX

(Address same as above)

Point-of-Contact: J.L. Somnier and/or J. Massol

c/o COMEX Services

(Address same as above)

Telephone: (91) 41.01.70 Marseille

Telex: 410985 F

MOB 1001 - 1002

CHARACTERISTICS

Length.....	N/A	Hatch Diameter.....	19.7 in. (50cm)
Beam.....	3.7 ft (2.7m)	Life Support Duration.....	144 man-hours
Height.....	12.6 ft (3.9m)	Total Power.....	20 KVA
Draft.....	N/A	Speed: Cruise (kts/hrs)....	NA
Weight (dry).....	10.5 tons (9.5t)	Max (kts/hrs).....	2 kts
Operating Depth.....	3,281 ft (1000m)	Crew: Pilot.....	1
Collapse Depth.....	9,186.8 ft (2800m)	Co-Pilot.....	1
Launch Date.....	1977	Payload.....	882 lbs (400kg)
		Color.....	Orange and black

Pressure Hull: One steel sphere, ID 7.2 ft (2.2m)

Power Source: Main: 440 VAC, 6 phases, 16 KW. Emergency: Internal batteries for emergency power provide 24 V - 270 Ah.

Maneuvering Control: Eight, fixed, reversible screw-type propellers. Four provide main forward propulsion, two are vertical and two are lateral thrusters. All are 1.5 hp.

Pitch/Trim: Two hard tanks of 200 l. (422.7 pts) capacity each.

Life Support: O₂ is carried externally in three tanks of 25 l. (6.6 gal) capacity each at 200 bars (2900 psi). CO₂ is removed by scrubbing through soda lime. The CO₂ scrubber has emergency power inside the pressure hull. Monitors for O₂, CO₂, temperature, humidity and pressure which are checked every 15 minutes. Electric heaters and dehumidifiers are also carried.

Viewing: Eight viewports total three of 23.6 in. (60cm), two girdle the hull equator, one looks down and forward, five 5.9 in. (15cm) diameter. External TV with internal monitoring and recording.

Manipulator: One, hydraulically powered, six degrees-of-freedom, the manipulator can lift 441 lbs (200kg). One prehensile arm, two degrees-of-freedom. One winch, 661.5 lbs (300 kg) lifting strength.

Lift Points: Three cables are attached to the top with a shackle.

External Lighting: Eleven lights total, all quartz iodide, six 300 W each, two 500 W each, three emergency lights 150 W each. One flashing, self-powered, white light rep. rate once every 10 seconds.

Surface Light: One flashing, self-powered, white light, rep. rate every two seconds.

Fire Extinguisher: One, dry chemical.

Emergency Food and Water: Equal to life support duration.

Surface Communications: Interphone. VHF (Svenska Mod. ME 60) multi-channel transceiver, 25 W power. Five channels for communications 10 Km (5.4nm) range, operate off both main and emergency power.

Sub-Surface Communications: One underwater telephone (TSM 5110) 8.08 kHz - 100 W - CW - operates off both main and emergency power. One Interphone, one real time TV, one genephone.

Surface Homing Devices: Optional, one transponder compatible with dynamic positioning system of mother ship.

Sonars: Scanning sonar (WESMAR SS 140 S), 160 KHz, 1,600 ft (487.7m) range, 360-degree scan, CRT display, beam width seven degrees, transducer tilt adjustable from the horizontal four degrees upward to 90 degrees downward. Echo sounder (KODEN Mod. 385 A) 75 KHz, three transducers (looking up, forward, down), maximum range: 300m (984.3 ft), strip chart recorder.

Jettisonable Components: Security weight: 882 lbs (400kg); Two manipulator arms: 485.1 lbs (220kg); Crock of the winch with its weight, Umbilical.

Emergency Breathing: Two Fenzy Mfg. providing four hours for each occupant.

Communication Procedure: Continuous.

System Readiness: Operational

Classification/Certification: ABS and DNV

Support Ship: MOB 1001 - PELERIN

MOB 1002 - DISCOVERER SEVEN SEAS

Owner(s): MOB 1001 - COMEX

13275 Marseille Cedex 2
France

MOB 1002 - Staubo & Co

Nefre Bollst 8
Oslo 1
Norway

Operator: COMEX

(Address same as above)

Builder: COMEX

(Address same as above)

Point-of-Contact: J. L. Somnier and/or J. Massol

c/o COMEX Services

(Address same as above)

Telephone: (91) 41.01.70 - Marseille

Telex: 410985 F

NEKTON ALPHA, BETA, GAMMA

CHARACTERISTICS

Length.....	15 ft (4.6m)	Hatch Diameter.....	18 in. (45.7cm)
Beam.....	3.5 ft (1.1m)	Life Support Duration.....	144 man hrs
Height.....	6 ft (1.8m)	Total Power.....	4.5 kWh
Draft.....	4 ft (1.2m)	Speed: Cruise (kts/hrs).....	1.5/3.5
Weight (dry).....	2.25 tons (2.3t)	Max (kts/hrs).....	2/1
Operating Depth.....	1,000 ft (305m)	Crew: Pilot(s).....	1
Collapse Depth.....	2,500 ft (762m)	Observer(s).....	1
Launch Date.....	1968, 70, 71	Payload.....	297 lbs (134kg)
		Color.....	Yellow

Pressure Hull: Cylindrical shape, composed of A-212 (ALPHA) and A-515 (BETA, GAMMA) mild steel, 9/16 in. (1.4cm) thick, 8 ft (2.4m) long and 3.5 ft (1.1m) ID. Conning tower is 2 ft (0.6m) diam. and 2 ft (0.6m) high.

Power Source: Eight 6 V, 190 amp-hr, lead acid batteries carried in the hull in a pressure-resistant compartment and delivering 24 V and 48 V. Auxiliary power is provided by a 12 V, 42 amp-hr lead acid battery in the hull, can run CO₂ scrubber system.

Maneuvering Control: Fixed, stern-mounted, reversible propeller. Starboard dive plane, rudder.

Life Support: Oxygen carried internally, two-72 ft³ (2.0m³) flasks at 2,200 psi (154kg/cm²). CO₂ removed by soda sorb, 16 lbs (7.2kg) carried. O₂ continuously monitored, cabin pressure monitored by aircraft altimeter. Environmental check every 20 minutes. Scrubber power is off the main or auxiliary batteries.

Viewing: Seventeen viewports located in conning tower and bow. TV camera inside hull.

Manipulator: One, manually-powered, 38 in. (96.5cm) long rod with scissors grip. Not jettisonable.

Lift Point(s): Normal lifting is by two 3/8 in. (0.8cm) shackles forward and aft of conning tower connected by a bridle. Auxiliary lift is by a strongback trending athwart the conning tower. Strongback attachment points are circular, 3/4 in. (1.9cm) diam. penetrations drilled in 0.5 in. (1.3cm) thick steel plate. Any one of the four attachment points can sustain vehicle's entire dry weight.

External Lighting: Eight, 150 w, thallium iodide lights, three each p/s on bow, one each p/s on stern.

Surface Lights: None routinely carried. Occasionally carries a 150 w light on the scanning sonar dome which may be used intermittently on the surface.

Emergency Food & Water: Water and food (candy) carried to provide endurance equal to that of life support. Exposure suits carried in cold water operations.

Surface Communications: VHF transceiver, 25 w, can operate off main and auxiliary power.

Sub-Surface Communications: One underwater telephone, 8.0875 kHz, powered off the main batteries. Communications check with surface every 35 minutes; if no communications within 70 minutes, the dive is aborted.

Sonars: Scanning sonar, manually trainable 360 degrees, audible display, mounted on conning tower (modified Straza Sea Probe) and operates in both active and passive mode. Active mode transmits and receives on 96 to 119 kHz, 200 yds (182m) max range, 19 degrees horizontal beam width. Passive mode receives 20 to 54 kHz. Self-powered, five days duration, can operate off main batteries. Pinger occasionally carried, 37 kHz, two sec. rep. rate, self-powered, 48 hr duration.

AD-A061 325

BUSBY (R FRANK) ASSOCIATES ARLINGTON VA
REVIEW OF MANNED SUBMERSIBLES DESIGN, OPERATIONS, SAFETY AND IN--ETC(U)
JUL 78

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Jettisonable Components: Manually droppable 180 lb (81.5kg) weight; 25 lb (11.3kg) propulser/rudder assembly is droppable. MBTs and VBT can be blown at operating depth to provide 1,500 lbs (680kg) and 30 lbs (13.6kg) positive buoyancy, respectively.

Emergency Breathing: Scuba regulators (two each) draw off main ballasting air.

Egress Procedure (underwater): Hull can be flooded and occupants may egress carrying emergency breathing regulators with tanks. This is a last resort and 200 ft (60.8m) depth is considered maximum.

System Readiness: Operational

Classification/Certification: BETA and GAMMA: ABS; ALPHA: none

Support Ship: R/V DAWN STAR & R/V SEAMARK can be used, but normally a ship of opportunity is employed.

Owner: General Oceanographics, Inc.
11578 Sorento Valley Rd., Suite 25
San Diego, Calif. 92121

Operator: Same as above

Builder: Same as above

Point-of-Contact: Mr. Merle D. Wilson
General Oceanographics, Inc.
(Address same as above)
Telephone: (714) 452-1792

NEREE

CHARACTERISTICS

Length.....	2.1m (7 ft)	Hatch Diameter.....	400mm (15.7 in)
Beam.....	1.35m (4.6 ft)	Life Support Duration.....	96 man hrs
Height.....	1.35m (4.6 ft)	Total Power.....	17.8 kWh
Weight (dry).....	1.6t (68 tons)	Speed: Cruise	2 kts
Operating depth.....	200m (656 ft)	Max	3 kts
Collapse Depth.....	NA	Crew: Pilot (s).....	1
Launch Date.....	1972	Payload.....	100 kg (220lbs)
		Color.....	White

Pressure Hull: One steel cylinder.

Power Source: Umbilical, lead acid batteries in pressure-resistant cylinder. Batteries deliver 120 volts at 135 amp-hr and 24 volts at 70 amp-hr.

Maneuvering Control: Five, fixed, reversible screw-type propellers. Two provide main forward propulsion, 3 hp each. Two are vertical, 1.5 hp each. One is lateral, 1.5 hp.

Pitch/Trim: Two hard tanks of 30 l (7.9 gal) each, \pm 25° bow angle by moving two weights inside the pressure hull.

Life Support: Oxygen is carried externally in two tanks of 12.5 l (3.3 gal) capacity each at 200 bars (2900 PSI). Carbon dioxide is removed by scrubbing through soda lime of which 70kg (154 lbs) is carried on each dive. The CO₂ scrubber has emergency power inside the pressure hull. Monitors for O₂, CO₂, temperature, humidity and pressure. One dehumidifier.

Viewing: Two viewports total. One 1.1m (44 in) 127° looking forward. One 550m 68 degrees looking backward. TV and recorder carried.

Manipulator: One, electrically driven, four degrees-of-freedom, jettisonable.

External Lighting: Six lights total, all quartz iodide. Four 250 watts each and two 300 watts each.

Surface Lights: One flashing, self-powered, white light, rep rate once every two seconds.

Fire Extinguisher: One, pulverised water.

Emergency Food and Water: Equal to life duration.

Surface Communications: VHF (SVENSKA Mod. ME 60) multi-channel transceiver, 25 watts power. Emergency and identification communication on channel 16 (156-180 mg) five channels for nominal communications 10 km (5.4nm) range. One interphone.

Sub-surface Communications: One underwater telephone (TSM 5110), 8.08 kHz, 100 W, CW, operates aft both main and emergency power. One interphone.

Jettisonable Components: Security weight 100 kg (220 lbs) umbilical, five propellers.

Emergency Breathing: Two (FENZY Mfg), providing four hours for each occupant.

Communication Procedure: Continuous.

System Readiness: Operational.

Owner: COMEX
13275 Marseille CEDEX 2
France

Operator: Same as above.

Builder: Same as above.

Point-of-Contact: J.L. Somnier and/or G. Didomenico
C/o COMEX Services
13275 Marseille CEDEX 2
France
Telephone: (91) 41.01.70
Telex: 410985 F

OPSUB

Length.....18 ft (5.2m)	Hatch Diameter.....N/A
Beam.....8.4 ft (2.6m)	Life Support Duration.....144 man hrs
Height.....7.5 ft (2.3m)	Total Power.....Tethered
Draft.....6.8 ft (2.1m)	Speed: Cruise (kts/hrs)...N/A
Weight (dry).....5.2 tons (4.7t)	Max (kts/hrs).....2/N/A
Operating Depth.....2000 ft (610m)	Crew: Pilot(s).....1
Collapse Depth.....N/A	Observer(s).....1
Launch Date.....1972	Payload.....750 lbs (340.2kg)
	Color.....White, International Orange hatch cover

Pressure Hull: Spherical shape, 66 in. (168cm) OD, 0.5 in. (1.3cm) thick and composed of HY 80 steel.

Power Source: An umbilical from the surface provides 50 kWh of power from a diesel generator providing 440 VAC regulated power. Communications, TV transmission and voltage sensing also passes through this wire. The umbilical is 1000 ft (305m) long, 1.4 in. (3.6cm) diameter and has a breaking strength of 10,000 lbs (4,536kg), it can be cut by the vehicle if necessary.

Maneuvering Control: Five motors provide propulsion. Three are for horizontal motion and are mounted port, starboard and aft, the aft motor is trainable 90° left and right. The remaining two motors are thrusters for horizontal and vertical control. All motors are oil-compensated, 10 hp, 350 lb thrust, and are reversible with two speeds forward and aft. Large weight changes are compensated for before the dive by changing external weights in the fixed ballast compartment on a droppable weight platform. Small buoyancy changes during the dive are obtained through a variable ballast tank (200 lb (91kg) capacity). The tank is flooded to fill and pumped dry.

Life Support: Three O₂ flasks are carried in the hull. CO₂ is removed by Baralyme in a forced-air scrubber. O₂ is monitored by a Teledyne Analyzer, CO₂ is monitored by a Drager Analyzer, a second Drager Analyzer (Multi-gas Detector Mod. 21) measures both CO₂ and CO. An altimeter measures cabin pressure. All life support monitors are checked every 30 minutes during the dive.

Viewing: There are 13 viewports total. Four are in the hull, eight in the conning tower and one in the hatch. Closed circuit TV is carried on a pan/tilt mechanism, monitors are on the submersible and the surface support ship.

Lift Points: A series of 0.5 in. (1.3cm) diameter circular holes are drilled through a flat metal plate located just aft of the conning tower which permits lifting at the exact center of gravity. The umbilical cable is not designed to carry the weight of the vehicle in air. A pipe frame which encircles the vehicle and also forms its two skids can support the vehicle's in air weight for lifting in an emergency.

External Lighting: Two (Birns & Sawyer Mfg.), 500 watt incandescent lights mounted on the bow. One mercury vapor light, 400 watts, is used in conjunction with the TV camera.

Life Jackets: Two, inflatable.

Surface Lights: Flashing strobe light mounted on conning tower.

Fire Extinguisher: One, dry chemical.

Surface Communications: Hardwire communications through umbilical.

Sonars: Scanning sonar (Wesmar SS150), 160kHz, 1000 ft (305m) range. Capable of scanning 360 degrees in the horizontal and 4 degrees above and 90 degrees below the horizontal.

Sub-Surface Communications: Hardwire transmission through umbilical. If the umbilical is severed an emergency acoustic underwater telephone is carried. Two transducers are used, one is located forward on the pipe frame and the other is on the keel. The range of the underwater telephone is 3,000 ft (915m).

Jettisonable Components: A 600 lb clump can be hydraulically released. The umbilical cable can be hydraulically cut if required. The weight of the umbilical cable and lift line is approximately 560 lbs (254kg) in water. A pin can be hydraulically retracted to release the lift line.

Emergency Breathing: Two scuba bottles containing compressed air are carried inside the pressure hull. Two face masks and two regulators/mouthpieces are provided. Each bottle provides approximately 2 man-hours duration.

Communications Procedure: No standard procedure has been established at present. If hardwire communications are lost the dive is aborted.

System Readiness: Operated in the summer of 1977 in the North Sea. Has not dived since.

Classification/Certification: ABS

Support Ship: M/V SAMSON DIVER or other ship of opportunity.

Owner: Ocean Systems International Inc.

1441 Park 10 Boulevard
Houston, Tx 77084

Operator: Ocean Systems (UK) Ltd

Woodside Road
Bridge of Don
Aberdeen AB2 8EF
Scotland

Builder: Perry Submarine Builders

Riviera Beach, Fl.

Point-of-Contact: Mr. L. Cushman

(Address same as operator)
Telephone: (0224) 702 562
Telex: 73264 SAMSON G

PC 5 C

CHARACTERISTICS

Length.....	22 ft (6.7m)	Hatch Diameter.....	22 in. (55.9cm)
Beam.....	4.7 ft (1.4m)	Life Support Duration.....	216 man hrs
Height.....	8.8 ft (2.65m)	Total power.....	115 kWh
Draft.....	5.5 ft (1.7m)	Speed: Cruise (kts/hrs)..	NA
Weight (dry).....	11 tons (10t)	Max (kts/hrs).....	NA
Operating Depth...	1,200 ft (366m)	Crew: Pilot(s).....	2
Collapse Depth....	2,000 ft (610m)	Observer(s).....	1
Launch Date.....	1968	Payload.....	700 lbs (319kg)
		Color.....	Yellow

Pressure Hull: Cylindrical shape with hemispherical end caps, composed of SA 212B steel.

Power Source: Lead acid batteries (34 each) in pressure-resistant containers supply 12 VDC at 140 amp-hrs rate. A 115 kWh electric power package is also provided.

Maneuvering Control: Main forward propulsion is supplied by a fixed, reversible, stern-mounted propeller powered by a 7.5 hp motor. Three thrusters of fractional hp are mounted, two forward and one aft. Dive planes and rudder assist in underway maneuvering.

Viewing: Twenty six viewports total, four in stern, nine girdle the conning tower and 13 are in the forward end cap.

Manipulator: One, six degrees-of-freedom, 9 functions, with various hand tools.

External Lighting: One, 300 w, and one 500 w quartz iodide, mounted on the bow.

Life Jackets: Three, inflatable.

Distress Rockets: Emergency signals fired by remote internal control panel. (Signal details not available.)

Surface Lights: One, white strobe light, 2 ft (0.6m) above water level, self-powered.

Fire Extinguisher: One, dry chemical

Emergency Food & Water: Amount not yet specified, type will be the same as PS-2.

Sub-Surface Communications: One underwater telephone (Helle Mfg.), 27 kHz, one transducer mounted topside.

Surface Homing Devices: Radio direction finder aboard support ship.

Jettisonable Components: One 881 lb (400kg) mechanically released weight.

Emergency Breathing: Three open-circuit regulators drawing off water deballasting air are provided. Approximately two hours is available to each occupant.

System Readiness: Overhaul

Classification/Certification: RINA (Registro Italiano Navale)

Support Ship: MV CAPALONGA or ship of opportunity

Owner: Sub Sea Oil Services

Via S. Vittore

45 Milano

Italy

Operator: Same as owner

Builder: Perry Submarine Builders, Inc.

Riviera Beach, Florida

Point-of-Contact: Ing. G. Santi, Gen. Mgr.

Address same as owner

Telephone 02-4983141

Cable: SUBSEA MILAN

Telex: 39204

PC8B (PC8)

CHARACTERISTICS

Length.....	18.5 ft (5.6m)	Hatch Diameter.....	22 in. (56cm)
Beam.....	5.75 ft (1.7m)	Life Support Duration.....	10 man days
Height.....	6.75 ft (2.1m)	Total Power.....	20 kWh
Draft.....	5 ft (1.5m)	Speed: Cruise (kts/hrs)..	2.5/6
Weight (dry).....	5.5 tons (5t)	Max (kts/hrs).....	4/2
Operating Depth..	800 ft (244m)	Crew: Pilot(s).....	1
Callapse Depth...1,800 ft (549m)		Observer(s).....	1
Launch Date.....	1971	Payload.....	250 lbs (113kg)
		Color.....	Yellow

Pressure Hull: Cylinder with hemispherical bow and conical end caps composed of low temperature carbon steel 13.7 ft (4.1m) long and 3/8 in. (0.95cm) thick.

Power Source: Lead acid batteries are carried within two pressure-resistant pods beneath the hull, providing 24 and 120 VDC.

Maneuvering Control: Static: One variable ballast of 160 lbs (73kg) capacity in the pressure hull which is free-flooding and pumped dry. Dynamic: All propulsion is provided by a stern-mounted, reversible propeller which is driven by a 7.5 hp motor within the pressure hull. Electro-hydraulic rudder and dive plane.

Life Support: Four O₂ flasks are located external to the hull and hold 72 ft³ (2.0m³) at 2,250 psi (157kg/cm²). CO₂ is routinely removed by soda sorb, LiOH is carried for emergency use. Emergency batteries are carried in the hull for the CO₂ scrubber. O₂, CO₂, temperature and pressure are monitored on a schedule dependent upon pilot's work load.

Viewing: Plastic bow dome (114 degree spherical segment); eight viewports girdle conning tower and one is in the hatch cover. A TV camera with recorder is carried in the hull.

Manipulators: Two, both are electro-hydraulically powered and neither is jettisonable. One is capable of four degrees-of-freedom, it is 46 in. (117cm) long, has a scissors-type claw and can lift 75 lbs (34kg). The second is capable of five degrees-of-freedom, (360 degree wrist rotate), it is 48 in. (122cm) long, has a parallel jaws-type claw and can lift 75 lbs.

Lift Point: An inverted fishhook-shaped lift point with the open end facing forward and mounted at the center of gravity just after the conning tower. The hook is 2 5/8 in. (6.6cm) x 3 3/4 in. (9.5cm) wide and high, respectively, its maximum opening is 3 3/8 in. (8.1cm) and a counterweighted bar restrains the lift hauser from slipping out of the hook once it is engaged. The counterweighted bar also serves to prohibit the hook from fouling on lines or cables.

External Lighting: Six lights total, five look forward and one aft. All are quartz iodide, four are 250 w and two are 500 w.

Life Jackets: Two, inflatable.

Smoke Pots: One, externally mounted, electrically-activated flare fixed to the vehicle, color: black.

Surface Lights: One, flashing, white light 3.5 ft (1.1m) above the waterline, once every three seconds rep. rate, powered off the main batteries.

Fire Extinguisher: One, dry chemical.

Emergency Food and Water: Food and water carried in amounts equal to ten man days life support. Food consists mainly of candies. Two gals (7.6 l) of water are carried. Other food sources are being investigated.

Surface Communications: CB transceiver, 5nm (8km) range, operates off the main batteries.

Sub-Surface Communications: One (Helle Mod. 3600) underwater telephone, 27 kHz, CW mode, operates off main battery and emergency battery in pressure hull.

Sonars: Wesmar (Mod. SS140) scanning sonar, 160 kHz, 360 degree scan in the horizontal displays both PPI and audio, powered off main batteries. Vertical sector scan four degrees above horizontal and 90 degrees below horizontal. Pingers: One, operates off main batteries, 27 kHz (Electronic Applique Mfg.).

Directional Antennae: One (Helle Mfg.) receiving between 20-45 kHz, trained by moving the vehicle.

Jettisonable Components: Mechanically releaseable 450 lbs (204kg) weight. Both MBTs and VBTs can be blown at operating depth.

Emergency Breathing: Scuba regulators draw off main ballasting air. Facemasks provided.

Communications Procedure: Check with surface every 15 minutes. Abort dive after 30 minutes if no contact.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: M/V INTERSUB ONE

Owner: Intersub

Estaque Gare - Chateau Bovis
13016 Marseille
France

Operator: Same as above

Builder: Perry Submarine Builders
Riviera Beach, Florida

Point-of-Contact: A. Courau
Intersub
(Address same as above)
Telephone: (91) 46.70.36
Telex: 400598 INTRSUB

PC-9 (TS-1)

CHARACTERISTICS

Length.....	26 ft (7.9m)	Hatch Diameter.....	24 in. (60cm)
Beam.....	7.1 ft (2.2m)	Life Support Duration.....	336 man-hrs
Height.....	8 ft (2.4m)	Total Power.....	49.9 kWh
Draft.....	5.3 ft (1.6m)	Speed: Cruise (kts/hrs)...	1/16
Weight (dry).....	11.3 tons (10.2t)	Max (kts/hrs).....	3/3
Operating Depth.....	1,350 ft (412m)	Crew: Pilot(s).....	1
Collapse Depth.....	2,500 ft (762m)	Observer(s).....	1
Launch Date.....	1970	Payload.....	1,000 lbs (452kg)
		Color.....	Orange above waterline, white below

Pressure Hull: Cylindrical shape, SA-537 Grade A normalized steel 9/16 in. (1.4cm) thick, 4.5 ft (1.4m) ID, 18.2 ft (5.5m) length.

Power Source: Twin battery pods contain lead-acid heavy duty batteries providing 120 VDC main power (41.6 kWh at 20 hrs) and 24 VDC auxiliary power (8.3 kWh at 20 hrs).

Maneuvering Control: Static: Two internal, fore/aft tanks control fine buoyancy or trim by ± 400 lbs (181kg). Dynamic: Main propulsion is from a variable speed, reversible, ten hp DC electric motor driving a stern propeller. One single speed reversible vertical bow thruster (1.5 hp) and two (1.5 hp) lateral thrusters provide low speed maneuvering.

Pitch/Trim: Two internal (fwd/aft) tanks of 91 lbs (41kg) capacity each can be differentially filled with sea water to attain up/down bow angles of \pm ten degrees. Additionally, batteries may be moved fore and aft.

Life Support: Four oxygen flasks, 240 ft³ (6.8m³) capacity each at 2,250 psi (157kg/cm²) are located externally. Soda sorb is used for routine removal of CO₂ and LiOH is carried in event of emergency. Every 15 minutes the following is monitored: O₂, CO₂, temperature, humidity and pressure. Backup devices are carried to monitor O₂ and CO₂.

Viewing: Twenty-one viewports, nine in the forward pressure hull, nine in conning tower and three aft. All are 6.25 in. (15.9cm) ID, 1.5in. (3.8cm) thick, 8 in. (20.3cm) OD. Three television cameras total; all with video recorders. Two are mounted p/s, each is on a pan and tilt mechanism.

Manipulators: One manipulator 6 ft (1.8m) long, electro-hydraulically powered, six degrees-of-freedom and capable of lifting 250 lbs (113kg). Parallel jaws and scissors-type claws, jettisonable.

Lift Point: Main lift point is aft of the conning tower and is configured similar to an inverted fish hook with the hook or barb side aft. The hook is 4 in. (10.1cm) wide, 3 in. (7.6cm) thick and has a minimal opening of 3 in. (7.6cm). A safety bar is slid across the opening to hold the lift hauser securely in place.

External Lighting: Five units total, all mounted forward. Three are 400 w each quartz iodide and two are 200 w each thallium iodide.

Life Jackets: Three, inflatable.

Surface Lights: Flashing (1/3 sec), white xenon light, 5 ft (1.5m) above waterline, self-powered, 50 hrs duration.

Fire Extinguisher: Two, dry chemical.

Emergency Food & Water: Food and water consists of life boat type rations.

Surface Communications: One, VHF (155 MHz), three channel transceiver, 20 w power, can operate off main batteries or an emergency source in the hull. About 20 nm (37km) range.

Sub-Surface Communications: One underwater telephone is carried and operates off the main batteries. It transmits and receives on either eight or 27 kHz.

Sonars: A Wesmar (Mod SS300) scanning sonar is mounted on the bow and can scan a 180 degree forward sector on 39 kHz. Display is PPI and audio. Pinger: The underwater telephone can act as a pinger with a one second rep. rate, 27 kHz, may be self-powered or may operate off the main batteries for a duration of three months. Transponder (Beacon): An AMF Mod. 365 acoustic beacon may be activated at selectable pulses (ten-100 second intervals) by a self-contained clock which can be synchronized with a shipboard clock to obtain slant range and (with suitable shipboard receivers) relative bearing. The PC-9 beacon transmits on ten kHz, is self-powered and will operate for six months at a 30 second reply rate.

Directional Antennae: A pinger/receiver (Hydro Products) is mounted on the bow to receive a 27 kHz pulse. It is trained by rotating the submersible and has an audio display.

Marker Buoy: Emergency buoy consists of a 10 in. (25cm) diam., international orange Grimsby float which is manually released (through hydraulics) and tethered to 2,000 ft (609m) of 0.25 in. (0.6cm) diam. nylon line.

Jettisonable Components: Eight hundred pounds (362kg) of lead can be manually jettisoned. The MBTs and VBTs can be emptied at operational depth to provide 1,150 lbs (520kg) and 400 lbs (181kg) of positive buoyancy, respectively. One manipulator weighing 200 lbs (91kg) can be jettisoned.

Emergency Breathing: Three scuba regulators can draw off the main air ballasting supply. Three facemasks are carried.

Communications Procedure: Underwater telephone check with surface every 15 minutes. If 30 minutes transpires with no contact, the dive is aborted.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: M/V SUBSEA II

Owner: P&O Subsea Ltd.

Sea Oil Support Base

Montrose

Angus

Scotland

Operator: Same as owner

Builder: Perry Submarine Builders

Riviera Beach, Fla.

Point-of-Contact: R. Lloyd

General Manager

P&O Subsea Ltd

(Address same as owner)

Telephone: Montrose 2883

Telex: 76301

PC-1201/PC1204/PC-1205

CHARACTERISTICS

Length.....	22 ft (6.7m)	Hatch Diameter.....	22 in. (56cm)
Beam.....	8 ft (2.4m)	Life Support Duration.....	10 man days
Height.....	8 ft (2.4m)	Total Power.....	33 kWh
Draft.....	6 ft (1.8m)	Speed: Cruise (kts/hrs)...	2.5/8
Weight (dry).....	8 tons (7.2t)	Max (kts/hrs).....	4/2
Operating Depth..	1,000 ft (305m) PC-1201	Crew: Pilot(s).....	1
	1,200 ft (366m) PC-1204	Observer(s).....	2
	1,200 ft (366m) PC-1205	Payload.....	750 lbs (340kg)
Collapse Depth...	2,000 ft (609m)	Color.....	Yellow
Launch Date.....	1975/1976/1978		

Pressure Hull: Cylindrical shape with hemispherical bow and cap and conical stern section. Hull diam. 42 in. (107cm).

Power Source: Lead acid batteries (48) in two pressure-resistant pods providing 24 and 120 VDC.

Maneuvering Control: Static: Main ballast tanks of 1,000 lbs (453kg) capacity and VBT of 180 lbs (82kg) capacity. Dynamic: Stern propeller, fixed and reversible (10 hp); two, one hp, reversible, fixed thrusters on bow, one for lateral and one for vertical movement. Rudder and dive planes electro-hydraulically controlled.

Life Support: Four O₂ flasks are located external to the hull and hold 72 ft³ (2.0m³) of gas at 2,250 psi (157kg/cm²). CO₂ is routinely removed by soda sorb and LiOH is carried for emergency use. O₂ is bled continuously into the hull, and emergency batteries are carried in the hull for the CO₂ scrubber. O₂, CO₂, temperature and pressure are monitored on a schedule dependent upon work load.

Viewing: Plastic bow dome (114 degree spherical segment); eight viewports girdle conning tower and one in hatch cover. A TV camera with recorder is carried in the hull.

Manipulators: Two, both are electro-hydraulically powered and neither is jettisonable. One is capable of four degrees-of-freedom, it is 46 in. (117cm) long, has a scissors-type claw and can lift 75 lbs (34kg). The second is capable of five degrees-of-freedom, (360 degree wrist rotate), it is 48 in. (122cm) long, has a parallel jaws-type claw and can lift 75 lbs (34kg).

Lift Points: An inverted fish hook-shaped with the open end trending forward and mounted at the center of gravity just aft of the conning tower. The "hook" is 2 5/8 in. (6.6cm) x 3 3/4 in. (9.5cm) wide and high, respectively, its maximum opening is 3 3/8 in. (8.1cm) and a counterweighted bar restrains the lift hauser from slipping out of the hook once it is engaged. The counterweighted bar also serves to prohibit the hook from fouling on lines or cables.

External Lighting: Six lights total, five look forward and one aft. All are quartz iodide, four are 250 w and two are 500 w.

Life Jackets: Two, inflatable.

Smoke Pots: One, externally-mounted, electrically-activated flare fixed to the vehicle, color: black.

Surface Lights: One, flashing, white light 3.5 ft (1.1m) above the waterline, once every three seconds rep. rate, powered off the main batteries.

Fire Extinguisher: One, dry chemical.

Emergency Food & Water: Food and water carried in amounts equal to ten man days life support. Food consists mainly of candies, two gal (7.6 l) of water are carried. Other food sources are being investigated.

Surface Communications: CB transceiver, 5nm (8km) range, operates off the main batteries.

Sub-Surface Communications: One (Helle mod. 3600) underwater telephone, 27 kHz, CW, operates off main battery. An emergency power supply is carried in the pressure hull.

Sonars: Wesmar (Mod. SS1405) scanning sonar, 160 kHz, 360 degree scan in the horizontal displays both PPI and audio, powered off main batteries. Vertical sector scan four degrees above horizontal and 90 degrees below horizontal. Pingers: One pinger operates off main batteries, 27 kHz. (Mfg. Electronic Applique).

Directional Antennae: One (Helle Mfg.) directional antennae receiving between 20-45 kHz, operates off main batteries, audible display, trained by moving submersible.

Jettisonable Components: Mechanically releaseable 450 lb (204kg) weight. Both MBTs and VBTs can be blown at operating depth.

Emergency Breathing: Scuba regulators draw off main ballasting air. Facemasks provided.

Communications Procedure: Check with surface craft every 15 minutes. Abort dive after 30 minutes if no contact has been made.

Systems Readiness: Operational

Classification/Certification: ABS

Support Ship: M/V INTERSUB TWO & FIVE

Owner: Intersub
Estaque Gare - Chateau Bovis
13016 Marseille
France

Operator: Same as above

Builder: Perry Submarine Builders
Riviera Beach, Fla.

Point of-Contact: A. Courau
Intersub
Estaque Gare - Chateau Bovis
13016 Marseille
France
Telephone: (91) 46.70.36
Telex: 400598 INTRSUB

PC-1202

CHARACTERISTICS

Length.....	31 ft (9.4m)	Hatch Diameter.....	22 in. (56cm)
Beam.....	8 ft (2.4m)	Life Support Duration....	360 man-hrs
Height.....	9 ft (2.7m)	Total Power.....	53 kWh
Draft.....	7 ft (2.1m)	Speed: Cruise (kts/hrs)..	1.5/10
Weight (dry)....	15 tons (13.6t)	Max (kts/hrs).....	2.5/NA
Operating Depth..	1,000 ft (305m)	Crew: Pilot(s).....	1
Collapse Depth...	2,000 ft (610m)	Observer(s).....	4 (2 divers)
Launch Date.....	1975	Payload.....	1,500 lbs (680kg)
		Color.....	Yellow

Pressure Hull: Cylindrical shape, steel, with hemispherical bow and conical stern. Inside diam. of pilot's (atmospheric pressure) compartment 48 in. (122cm); ID of LOC is 54 in. (137cm).

Power Source: Lead acid batteries. 24 & 120 VDC, 90 amp-hrs, carried in two droppable, pressure-resistant pods.

Maneuvering Control: Static: VBTs totaling 465 lbs (210kg) capacity. Dynamic: A ten hp, fixed, reversible stern propeller provides main propulsion; one vertical and two horizontal thrusters of one hp each provide auxiliary propulsion. Dive planes and rudder assist dynamic maneuvering.

Pitch/Trim: Up/down bow angles can be obtained by differentially filling the VBTs. Degrees of pitch unknown at time of survey.

Life Support: Four O₂ flasks of 72 ft³ (2.0m³) capacity each at 2,250 psi (157kg/cm²) are carried externally. A total of 7,500 ft³ (212m³) of mixed gas (HeO₂) is available for lockout diving. CO₂ is routinely removed by soda sorb and LiOH is carried for emergency use. O₂ is bled continuously into the hull and emergency batteries are carried in the hull for the CO₂ scrubber. O₂, CO₂, temperature and pressure are monitored on a schedule dependent upon occupant work load.

Viewing: Plastic bow dome (114 degree spherical segment); seven viewports girdle conning tower, one is in the hatch cover and two are in the LOC. A TV camera with recorder is carried in the hull.

Manipulators: Two, both are electro-hydraulically powered and neither is jettisonable. One is capable of four degrees-of-freedom, it is 46 in. (117cm) long, has a scissors-type claw and can lift 75 lbs (34kg). The second is capable of five degrees-of-freedom, (360 degree wrist rotate), it is 48 in. (122cm) long, has a parallel jaws-type claw and can lift 75 lbs (34kg).

Lift Points: One standard hook-shaped metal point aft of the conning tower with the opening pointing forward. The hook is 2 7/8 in. (7.1cm) wide, 3 3/8 in. (8.6cm) high and has a minimal opening of 4 in. (10.1cm). A counter-weighted metal bar holds in the lift line and also prevents the hook from fouling.

External Lighting: Eight lights total, all quartz iodide, six are mounted forward and two on the stern. The six forward lights are 250 w, the two stern lights are 500 w.

Life Jackets: Five, inflatable.

Smoke Pots: One, externally-mounted, electrically activated flare fixed to the vehicle, color: black.

Surface Lights: One, flashing, white light 3.5 ft (1.1m) above the waterline, once every three seconds rep. rate, powered off the main batteries.

Fire Extinguisher: Two, in forward compartment, dry chemical.

Emergency Food & Water: Food and water carried in amounts equal to ten man days life support. Food consists mainly of candies. Five gals (18.9 l) of water are carried. Other food sources are being investigated.

Medical Supplies: A medical lock chamber allows for passage of material from the atmospheric chamber to the LOC.

Surface Communications: CB transceiver, 5nm (8km) range, operates off the main batteries.

Sub-Surface Communications: One (Helle Mfg. Mod. 3600) underwater telephone, 27 kHz, CW mode, operates off the main battery and has an emergency power supply in the pressure hull.

Sonars: Wesmar (Mod. SS140S) Scanning Sonar, 160 kHz, 360 degree scan in the horizontal, displays both PPI and audio, powered off main batteries. Vertical sector scan four degrees above horizontal and 90 degrees below horizontal. Pingers: One, operates off main batteries, 27 kHz. (Mfg. Electronic Applique).

Jettisonable Components: Both battery pods are hydraulically droppable and total 3,000 lbs (1,359kg).

Emergency Breathing: Scuba regulators draw off main ballasting air. Facemasks provided.

Egress Procedure: Exit from the LOC is an established routine. No provisions are made to exit from the forward compartment.

Communications Procedure: Check with surface every 15 minutes. Abort dive after 30 minutes if no contact has been made.

Systems Readiness: Operational

Classification/Certification: ABS

Support Ship: M/V INTERSUB THREE

Owner: Intersub

Estaque Gare - Chateau Bovis
13016 Marseille
France

Operator: Same as above

Builder: Perry Submarine Builders
Riviera Beach, Fla.

Point-of-Contact: A. Courau
Intersub
(Address same as above)
Telephone: (91) 46.70.36
Telex: 400598 INTRSUB

PC-1203

CHARACTERISTICS

Length.....	22 ft (6.7m)	Hatch Diameter.....	22.75 in. (57.8cm)
Beam.....	7.8 ft (2.4m)	Life Support Duration.....	160 man hrs
Height.....	7.9 ft (2.4m)	Total Power.....	35.1 kWh
Draft.....	5.6 ft (1.7m)	Speed: Cruise (kts/hrs)...	1/12
Weight (dry).....	8 tons (7.3t)	Max (kts/hrs).....	3/NA
Operating Depth..	1,000 ft (305m)	Crew: Pilot(s).....	1
Collapse Depth...	2,000 ft (610m)	Observer(s).....	1
Launch Date.....	1976	Payload.....	750 lbs (330kg)
		Color.....	Gray, white, orange

Pressure Hull: Cylindrical shape with hemispherical end cap on bow and conical shaped stern section, 48 in. (121cm) ID.

Power Source: Lead acid batteries in pressure-resistant pods providing 29.3 kWh at 120 VDC and 5.8 kWh at 24 VDC.

Maneuvering Control: Static: MBTs of 800 lbs (362kg) capacity; VBT of \pm 180 lbs (397kg) capacity. Dynamic: Main propulsion from a stern-mounted, fixed, reversible ten hp, screw-type propeller, two thrusters on bow one vertical and one lateral. Rudder and dive planes.

Life Support: Oxygen carried inside hull in four flasks totaling 423 ft³ (12m³) at STP. CO₂ is removed by LiOH. Monitors for O₂, CO₂, temperature and humidity.

Viewing: Eight viewports all 8 in. (20cm) major diam., seven girdle the conning tower and one is in the hatch cover. One 36 in. (91cm) diam. plastic, hemispherical bow dome. One TV in hull.

Manipulators: Two, one with five and one with six degrees-of-freedom (wrist rotate in one). Both hydraulically-powered, 68 in. (173cm) total length, parallel jaws-type claws with max opening of 4 in. (10cm) and 600 lbs (272kg) maximum grip force. Lift at maximum extension is 120 lbs (54kg). Not jettisonable.

Lift Points: NA

External Lighting: Four total. Two, 500 w each on bow, quartz iodide; one each p/s, 300 w each.

Life Jackets: Two, inflatable

Fire Extinguisher: One, dry chemical

Emergency Food & Water: Equal to life support duration.

Surface Communications: CB and VHF, (23 channel, 27 MHz) transceivers.

Sub-Surface Communications: One (Mesotech Mfg.) dual frequency (8 & 27 kHz) underwater telephone outputting at 20 & 100 w.

Sonars: Scanning sonar: One, (SS140S Wesmar), 160 kHz. Echo sounder: One, (Kode Mfg.) multiscale looking either up, forward or down, 8 kHz.

Jettisonable Components: Keel weight of 400 lbs (181kg). MBT blow and VBT pump at operating depth provides a total of 980 lbs (444kg) positive buoyancy.

Emergency Breathing: Two Fenzy, closed-circuit breathing devices of four hrs duration each.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: M/V PROTEE

Owner: COMEX
13275 Marseille Cedex 2
France

Operator: Same as owner

Builder: Perry Submarine Builders
Riviera Beach, Fla.

Point-of-Contact: J.P. Gres and/or R. Morris
COMEX Diving Ltd.
Bucksburn House
Howes Rd.
Bucksburn Aberdeenshire
AB29RQ
Scotland
Telephone: Aberdeen 55680

PC-14C-2

CHARACTERISTICS

Length.....	19.6 ft (6m)	Hatch Diameter.....	21 1/4 in. (56cm)
Beam.....	5.9 ft (1.8m)	Life Support Duration.....	180 man hrs
Height.....	8 ft (2.4m)	Total Power.....	17 kWh
Draft.....	6 ft (1.8m)	Speed: Cruise (kts/hrs)...	1/5
Weight (dry).....	5.9 tons (5.4t)	Max (kts/hrs).....	2.5/1
Operating Depth..	600 ft (183m)	Crew: Pilot(s).....	1
Collapse Depth...	1,800 ft (549m)	Observer(s).....	1
Launch Date.....	1975	Payload.....	400 lbs (181kg)
		Color.....	Yellow

Pressure Hull: Cylindrical shape with conical (stern) and hemispherical (bow) end caps, composed of A 537 Cl.1 steel 3/8 in. (0.15cm) thick and a bow section of acrylic plastic 36 in. (91cm) diam. Cylinder is 42 in. (107cm) diam. and 6.9 ft (2.1m) length.

Power Source: Lead acid batteries in a jettisonable, pressure-resistant pod consisting of 15, 12 V batteries in five, 36 V banks delivering 475 amp-hrs. One auxiliary battery of 12 V at 95 amp-hrs.

Maneuvering Control: One stern-mounted, reversible propeller powered by a three hp motor. Can turn 360 degrees in a 30 ft (9.1m) diam. circle. Static maneuvering by filling or pumping dry a 100 lb (45kg) capacity VBT.

Pitch/Trim: No systems available, however, a roll angle of ± 5 to 10 degrees can be obtained by differentially filling the MBTs.

Life Support: Five flasks of O₂ at 2,000 psi (140kg/cm²) totaling 120 ft³ (3.4m³) are carried inside the pressure hull. Six qts (5.7 l.) of baralyme are routinely carried to scrub CO₂; two cannisters of LiOH are carried for emergency use. Monitors for O₂, CO₂, pressure and temperature. Backup monitors for O₂ and CO₂. O₂ is bled continuously into hull and monitored every 30 min.

Viewing: Bow view dome of 36 in. (91cm) diam. and eight, 8 in. (20cm) diam. viewports in conning tower.

Lift Point: One shackle mounted 2 ft (0.7m) aft of conning tower and trending athwartships. Shackle is 5 in. (13cm) major inside length and 3.75 in. (9.5cm) inside width. Shackle lays flat during dive.

Life Jackets: Two, inflatable (also 2 emergency scuba tanks w/regs; 3 scuba masks)

Fire Extinguisher: One, dry chemical

Surface Communications: VHF-FM transceiver, 173.8 MHz, operates off 12 VDC from main batteries.

Sub-Surface Communications: One underwater telephone (Helle Mod. 3600), 27 kHz, operates off main batteries.

Sonar: Pinger: One, self-powered, rep. rate: one/sec., duration three to four days, salt water and/or manually activated, 45 kHz.

Marker Buoys: A marker buoy is towed to track vehicle during every dive.

Jettisonable Components: Battery pod of 2,500 lbs (1,133kg) is manually releaseable. MBTs and VBT can be emptied at maximum operating depth to provide 580 lbs (263kg) of positive buoyancy.

Emergency Breathing: Scuba regulators and mouth pieces draw off MBT air blow, 540 man min. are estimated as the systems duration.

Communications Procedure: Dive aborted after 20 minutes if no contact with surface.

Egress Procedure (underwater): May be accomplished by flooding hull through VBT manifold and compartment vent.

Note: Scuba tanks used during egress procedure for ascent to surface.

System Readiness: Operational

Classification/Certification: None

Support Ship: M/V NEPTUNE

Owner: U.S. Army

Ballistic Missile Defense Systems Command

P.O. Box 1500

Huntsville, Alabama 35807

Operator: Kentron Hawaii Ltd.

(KMR Technical Support Contractor)

Builder: Perry Submarine Builders, Inc.

Riviera Beach, Fla. 33404

Point-of-Contact: Neal McLemore

P.O. Box 1207

APO San Francisco 96555

or

Kentron Hawaii Ltd.

2003 Byrd Spring Rd.

Huntsville, Alabama 35802

Telephone: (205) 883-9690

PC-16

CHARACTERISTICS

Length.....25 ft (7.6m)	Hatch Diameter.....22 in. (56cm)
Beam.....8 ft (2.4m)	Life Support Duration.....240 man hrs
Height.....9 ft 6 in. (3m)	Total Power.....52 kWh
Draft.....NA	Speed: Cruise (kts/hrs)..1/8
Weight (dry).....15 tons (13.6t)	Max (kts/hrs).....2/1½
Operating Depth..3,000 ft (914m)	Crew: Pilot(s).....1
Collapse Depth...4,500 ft (1,372m)	Observer(s).....2
Launch Date.....1976	Payload.....750 lbs (340kg)
	Color.....Yellow

Pressure Hull: Three interconnected (bolted) steel spheres, 72 in. (183cm) diameter. Two hatches, one atop forward sphere and one under middle sphere for dry, one atmosphere, transfer.

Power Source: Lead acid batteries in pressure-resistant, droppable pods. Batteries supply 120 V and 24 VDC.

Maneuvering Control: Main propulsion is provided by a ten hp electric motor driving a screw-type, reversible, stern-mounted propeller. Three thrusters for low speed maneuverability, two are mounted on bow planes and can be oriented in the vertical or horizontal plane, the third is also on the bow and provides lateral thrust. Rudder and bow planes are electro-hydraulically driven.

Pitch/Trim: A variable buoyancy/trim system consisting of two external hard tanks of 200 lbs (91kg) capacity can be used to obtain \pm bow angles.

Life Support: O₂ is carried externally and can be bled continuously into the pressure hull. Two CO₂ scrubbers (one each in the forward and middle sphere) utilizing LiOH. Three, man-powered breathing systems are included which consist of face mask, hose and cannister. Primary and backup monitors for O₂ and CO₂, monitors for temperature, humidity and cabin pressure.

Viewing: Eight viewports total. Six girdle the conning tower and one is in the hatch cover. The eighth is in the dry transfer hatch cover. The forward sphere includes a 30 in. (76cm) diameter, acrylic plastic dome.

Manipulators: Two hydraulically-powered, mounted forward on the bow. Maximum length 55 in. (140cm), lift capacity - 75 lbs (34kg) at maximum extension. Two types of claws, one is parallel jaws; the second is scissors-type, maximum opening - 3 in. (7.6cm), 200 lbs (91kg) grip force. The manipulator with the parallel jaws claw has wrist rotate. The scissors-type claw manipulator has two degrees-of-freedom, linear extension, but no wrist rotate. Manipulators are not jettisonable.

Lift Point: Single point lift consisting of a steel padeye located amidships aft of the conning tower. Three circular apertures in the padeye allow for variations in trim.

External Lighting: Two, 500 w each (Birns & Sawyer Mod. 5565), incandescent lights mounted forward on bow guard rail.

Life Jackets: Three, inflatable

Surface Lights: Flashing white strobe, 0.1 w second flash once every two seconds, approximately 100 hrs duration. Visibility estimated at 22nm (40.8km) from aircraft.

Fire Extinguisher: Dry chemical (quantity undecided at time of survey).

Surface Communications: CB transceiver 5nm (8km) range, operates off the main batteries.

Sub-Surface Communications: One, underwater telephone (Mesotech Mfg.) transmitting on 8 or 27 kHz.

Sonars: Scanning sonar (Wesmar SS140S) transmitting on 160 kHz, range - 1,600 ft (488m). Transducer is laterally trainable 360 degrees and can be tilted in the vertical plane to four degrees upward or 90 degrees downward from the horizontal. In the 90 degree downward mode it may act as an echo sounder.

Jettisonable Components: Battery pods

Emergency Breathing: Four face masks and regulators are connected to the high pressure air system which consists of two tanks holding 2,000 ft³ (57m³) at 5,000 psi (352kg/cm²).

System Readiness: Operational

Classification/Certification: ABS

Support Ship: INTERSUB VESSEL

Owner: Intersub

Estaque Gare - Chateau Bovis
13016 Marseille
France

Operator: Same as owner.

Builder: Perry Submarine Builders
Riviera Beach, Florida

Point-of-Contact: A. Courau
Intersub
(Address same as owner)
Telephone: (91) 46.70.36
Telex: 400598 INTRSUB

PC 1801/1802/1804

CHARACTERISTICS

Length.....22 ft (6.7m)	Hatch diameter.....22 in. (56cm)
Beam.....8 ft (2.4m)	Life Support Duration.....672 man-hrs
Height.....8.5 ft (2.6m)	Total Power.....37 kWh
Draft.....N/A	Speed: Cruise (kts/hrs)..1/8
Weight (dry).....10 tons (9.1t)	Max (kts/hrs).....2.5/N.A.
Operating Depth..1,000 ft (305m)	Crew: Pilot(s).....1
Collapse Depth...2,000 ft (610m)	Observer(s).....3 (2 divers)
Launch Date.....1977/78	Payload.....1,000 lbs (454kg)
	Color.....Yellow

Pressure Hull: Cylindrical shape, steel, with hemispherical bow and conical stern. Inside diameter of pilot's (atmospheric pressure) compartment 54 in. (137cm); ID of LOC is 54 in. (137cm).

Power Source: Lead acid batteries. 24 and 120 VDC, 60 amp. hrs., carried in two droppable, pressure-resistant pods.

Maneuvering Control: Static; VBT's totaling 700 lbs (317kg) capacity. Dynamic: A ten hp pivoting, reversible stern propeller provides main propulsion; two thrusters of one hp each provide auxiliary propulsion. Dive planes and rudder assist dynamic maneuvering.

Pitch/Trim: Up/down bow angles can be obtained by differentially filling the VBTs.

Life Support: O₂ is carried externally and can be bled continuously into the pressure hull. A total of 6,000 ft³ (170m³) of mixed gas (HeO₂) is available for lockout diving. CO₂ is routinely removed by soda sorb and LiOH is carried for emergency use. O₂ is bled into hull continuously and emergency batteries are carried in the hull for the CO₂ scrubber. O₂, CO₂ temperature and pressure are monitored on a schedule dependent upon occupant work-load.

Viewing: Plastic bow dome (35 in. (90cm) major-diameter hemispherical); eight equally spaced 8 in. (20cm) major-diameter viewport in hatch, intercompartment hatch, internal DLO hatch, external DLO hatch each having one 8 in. (20cm) major-diameter viewport. VTR equipment is carried within the hull.

Manipulators: DSW 51 Deep submergence work package with two manipulators, both are electro-hydraulically powered by external hydraulic supply. Both are capable of following movements: shoulder up and down - 90 degrees, shoulder side to side - 90 degrees, wrist rotation - 360 degrees continuous, jaw open - 4 in. (10cm), maximum lift (fully extended - 150 lbs (67kg)). DSWP also capable of operating an impact wrench and grinder.

Lift Points: One standard hook-shaped metal point aft of the conning tower with the opening pointing forward. Three circular apertures in the padeye allow for variations in trim.

External Lighting: Eight lights total, all quartz iodide, six are mounted forward and two on the stern. 500 w and 250 w.

Life Jackets: Four, inflatable.

Smoke Pots: One, externally-mounted, electrically activated flare fixed to the vehicle, color: black.

Surface Lights: One, flashing, white light 3.5 ft (1.1m) above waterline, once every three seconds rep. rate, self-powered.

Fire Extinguisher: Two, in forward compartment, dry chemical.

Emergency Food and Water: Food and water carried in amounts equal to seven man days life support. Food consists mainly of candies.

Medical Supplies: A medical lock chamber allows for passage of material from the atmospheric chamber to the LOC.

Surface Communications: CB transceiver 5nm (8km) range, operates off the main batteries.

Sub-Surface Communications: One Helle underwater telephone, 27kHz, CW mode, operates off the main battery and has emergency power supply in the pressure hull.

Sonars: Wesmar (Mod. SS140S) Scanning Sonar, 160 kHz, 360 degree scan in the horizontal, displays both PPI and audio, powered off main batteries. Vertical sector scan four degrees above horizontal and 90 degrees below horizontal. In the 90 degree downward mode it may act as an echo sounder.

Jettisonable Components: Both battery pods are hydraulically droppable.

Emergency Breathing: Built-in emergency breathing system, masks and life vests.

Egress Procedure: Exit from the LOC is an established routine. No provisions are made to exit from the forward compartment.

System Readiness: PC 1801 and 1802 operational, PC 1804 in March 1978.

Classification/Certification: ABS

Support Ship: M/V INTERSUB THREE OR FOUR

Owner: Intersub

Estaque Gare - Chateau Bovis

13016 Marseille

France

Operator: Same as owner

Builder: Perry Submarine Builders

Riviera Beach, Florida

Point-of-Contact: A. Courau

Intersub

(Address same as above)

Telephone: (91) 46.70.36

Telex: 400598 INTRSUB

P2

CHARACTERISTICS

Length.....	19 ft (5.8m)	Hatch Diameter.....	19.5 in. (49.5cm)
Beam.....	10.5 ft (3.2m)	Life Support Duration.....	352 man hrs
Height.....	10.2 ft (3.1m)	Total Power.....	40 kWh
Draft.....	7.5 ft (2.3m)	Speed: Cruise (kts/hrs)....	NA
Weight (dry).....	26,208 lbs (11.9t)	Max (kts/hrs).....	2/NA
Operating Depth...	2,400 ft (732m)	Crew: Pilot(s).....	1
Collapse Depth....	5,000 ft (1524m)	Observer(s).....	2
Launch Date.....	1969	Payload.....	1500 lbs (680kg)
		Color.....	Red

Pressure Hull: Spherical shape, Corten B Steel 6.7 ft (2.04m) OD.

Power Source: Lead acid batteries, pressure-compensated, divided into main and auxiliary sections. Main: 120V - 235AH @ 5 hr rate. Emergency 12V: 20 amp-hrs Auxiliary: 24V - 300AH @ 8 hr rate (10 Lucas pacemakers); 12V - 120AH @ 8 hr rate (2 Lucas pacemakers).

Maneuvering Control: Two propulsion units consisting of two, reversible, screw-type propellers mounted p/s, each unit is driven by a three hp motor.

Pitch/trim: Oil is pumped forward or aft to provide approximately \pm 15 degrees bow angle.

Life Support: Four flasks of O₂ are carried, three are located in the pressure hull and hold 64 ft³ (1.8m³) each and two are carried externally and hold 70 ft³ (2m³) each. CO₂ is removed by scrubbing through LiOH. Monitors for CO₂, CO, temperature, humidity and pressure; monitoring of these properties is every 15 minutes.

Viewing: Three viewports, all on the bow looking forward. Television camera mounted externally on pan and tilt.

Manipulators: Two, both hydraulically-powered and both have jettisonable claws. One has two degrees-of-freedom and is designed for 2000 lbs (907kg) grasping capacity. The second has six degrees-of-freedom and is designed for 200 lbs (90.7kg) grasping capacity. The heavy lift manipulator has an opposing 'C' shaped claw, the lighter lift manipulator has a parallel jaws-type claw.

Lift Points: A flat, steel plate shaped into a 'Rams Horns' configuration. Two holes in the plate; one is circular and approximately 2.5 in. (6.4cm) ID; the second is elliptical and approximately 4 in. (10.2cm) long and 2.5 in. (6.4cm) wide.

External Lighting: Three, 1000w each, quartz iodide lights mounted forward above viewports.

Life Jackets: Two, inflatable.

Fire Extinguisher: Two Halon 1301.

Emergency Food and Water: Seven pints (3.3 l.) of canned water for each occupant and dehydrated food equal to 14 man days of life support. Two pair wool socks, two sweaters, two thermal blankets.

Medical Supplies: First aid kit.

Surface Communications: VHF transceiver operating on 157.65, 156.80 and 156.65 mHz. Range approximately 3nm (5.6km).

Sub-Surface Communications: One underwater telephone (Subcom Mod. 2005-20B) transmitting on 10 or 27 kHz. Four transducers - two face upward and two down, emergency power provided.

Sonars: Scanning sonar (Wesmar SS140S) trainable \pm 90 degrees p/s and transmitting on 160 kHz. Pinger mode in underwater telephone, emits on 10 or 27 kHz, one ping every three seconds, emergency 24V power supply provided. Transponder (AMF Mfg.) receives on 10 kHz, responds on 11 kHz.

Marker Buoy: One, red, rounded (Grimsby Mfg.), metal float, 8 in. (20cm) diameter.

Jettisonable Components: Propulsion motors (two each), 400 lbs (181kg) weight, manipulator claws. Total weight approximately 828 lbs (375.6kg).

Emergency Breathing: Three, self-contained oxygen rebreathers providing 15 minutes for each occupant.

Communications Procedure: Surface check every 15 minutes, dive is aborted if communications are not established after 30 minutes.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: VICKERS Series

Owner: Vickers Oceanics Ltd.

P. O. Box 8

Barrow-in-Furness

Cumbria, LA13 1AD

England

Operator: Vickers Oceanics Ltd.

P. O. Box 215

Leith Docks

Edinburgh EH6 6ND

Scotland

Builder: International Hydrodynamics Ltd.

N. Vancouver, B.C.

Canada

Point-of-Contact: Base Duty Officer

Vickers Oceanics Ltd.

(Address same as operator)

Telephone: 031 554 4411

Telex: 72248

P3

CHARACTERISTICS

Length.....	19.3 ft (5.9m)	Hatch Diameter.....	20.9 in. (53cm)
Beam.....	10.5 ft (3.2m)	Life Support Duration.....	352 man hrs
Height.....	10.5 ft (3.2m)	Total Power.....	40 kWh
Draft.....	7.5 ft (2.3m)	Speed: Cruise (kts/hrs)....	NA
Weight (dry).....	25872 lbs (11.9t)	Max (kts/hrs).....	2/NA
Operating Depth.....	3000 ft (914m)	Crew: Pilot(s).....	1
Collapse Depth.....	5600 ft (1707m)	Observer(s).....	2
Launch Date.....	1969	Payload.....	1500 lbs (680kg)
		Color.....	White

Pressure Hull: Spherical shape, Corten B steel, 6.7 ft (2.04m) OD.

Power Source: Lead acid batteries, pressure-compensated, divided into main and auxiliary sections. Main batteries: 120V - 235AH @ 5 hr rate. Emergency: 12V - 120AH. Auxiliary: 24V - 180AH @ 8 hr rate (6 x Lucas 12V pacemakers); 12V - 120amp-hrs @ 8 hr rate (2 x Lucas 12V pacemakers).

Maneuvering Control: Two propulsion units consisting of two, reversible, screw-type propellers mounted p/s, each unit is driven by a five hp motor.

Pitch/Trim: Oil is pumped forward or aft to provide approximately ± 15 degrees bow angle.

Life Support: Five flasks of O₂ are carried, three being located in the pressure hull and hold 64 ft³ (1.3m³) each, two are located externally and hold 70 ft³ (2m³) each. CO₂ is removed by scrubbing through LiOH. Monitors for O₂, CO₂, temperature, humidity and pressure; monitoring of these properties is approximately every 15 minutes.

Viewing: Three viewports on bow, all look forward. Television mounted externally on pan and tilt.

Manipulators: Two, both hydraulically powered and both have jettisonable claws. One has two degrees-of-freedom and is designed for 2000 lbs (907kg) grasping capacity. The second has six degrees-of-freedom and is designed for 200 lbs (90.7kg) grasping capacity. The heavy lift manipulator has an opposing "C" shaped claw, the lighter lift manipulator has a parallel jaws type claw.

Lift Points: A flat, steel plate shaped into a 'Rams Horns' configuration. Two holes in the plate; one is circular and approximately 2.5 in. (6.3cm) ID; the second is elliptical and approximately 4 in. (10.2cm) long and 2.5 in. (6.3cm) wide.

External Lighting: Three, 1000 w each, quartz iodide lights mounted forward above viewports.

Life Jackets: Two, inflatable.

Surface Lights: Flashing white light, 3 ft (0.9m) above water surface, once every three seconds flash rate, self-powered.

Fire Extinguisher: Two, Halon 1301.

Emergency Food & Water: Seven pints (3.3 l.) of canned water for each occupant and dehydrated food equal to 14 man days of life support. Two pr wool socks, two sweaters, two thermal blankets.

Medical Supplies: First aid kit.

Surface Communications: VHF transceiver operating on 157.65, 156.80 and 156.65 mHz. Range approximately three nm (5.6km). Emergency power supply provided.

Sub-Surface Communications: One underwater telephone (Subcon Mod. 2005-20B) transmitting on 10 or 27 kHz. Four transducers, two face upward and two down, emergency power provided.

Sonars: Scanning sonar (Wesmar SS120S) trainable ± 90 degrees p/s and transmitting on 155 kHz. Pinger mode in underwater telephone, emits on 10 or 27 kHz, responds on 11 kHz. Directional Hydrophone (Helle Mfg.) receiving on 10 and 27 kHz.

Marker Buoys: One, red, 10 in. (25.4cm) diameter sphere attached to 4000 ft (1219m) of line.

Jettisonable Components: Propulsion motors (two each), 450 lbs (204kg) weight, manipulator claws. Total weight approximately 883 lbs (401kg).

Emergency Breathing: Three (Emox Mfg.) self-contained, oxygen rebreathers provide 45 minutes for each occupant.

Communications Procedure: Surface check every 15 minutes, dive aborted if communications not established after 30 minutes.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: VICKERS series

Owner: Vickers Oceanics Ltd.

P.O. Box 8

Barrow-in-Furness

Cumbria, LA14 1AD

England

Operator: Vickers Oceanics Ltd.

P.O. Box 215

Leith Docks

Edinburgh EH6 6ND

Scotland

Builder: International Hydrodynamics Ltd.

N. Vancouver, B.C.

Canada

Point-of-Contact: Base Duty Officer

Vickers Oceanics Ltd.

(Address same as operator)

Telephone: 031 554 4411

Telex: 72248

PISCES IV

CHARACTERISTICS

Length.....	20 ft (6.1m)	Hatch Diameter.....	19.4 in. (49.3cm)
Beam.....	10 ft (3.0m)	Life Support Duration.....	216 man hrs
Height.....	12 ft (3.7m)	Total Power.....	46.2 kWh
Draft.....	8 3/4 ft (2.7m)	Speed: Cruise (kts/hrs)...	0.5/10
Weight (dry)....	22,843 (10,362kg)	Max (kts/hrs).....	1.5/5.5
Operating Depth..	6,600 ft (2,012m)	Crew: Pilot(s).....	1
Collapse Depth...	9,000 ft (2,743m)	Observer(s).....	2
Launch Date.....	1972	Payload.....	1,000 lbs (455kg)
		Color.....	White; orange dayglow sail

Pressure Hull: Spherical shape, HY-100 steel, 80 in. (2.03m) diam., 1,038 in. (2.63cm) thick. Coated externally and internally with fiberglass.

Power Source: Lead acid batteries, 120 V, 385 amp-hr., pressure compensated.

Maneuvering Control: Two, five hp each, reversible thrusters mounted p/s amidships. Thrusters are rotatable 90 degrees upward to 15 degrees downward from the horizontal.

Life Support: Four O₂ flasks of 73.3 ft³ (2.1m³) capacity each are carried in pressure hull. O₂ is continuously supplied at 0.4 l./min/man. CO₂ is routinely removed by Dragorsorb and four 6.4 lb (2.9kg) capacity (each) LiOH cannisters are carried for emergency. O₂ is monitored regularly. CO₂ is routinely monitored every two hours. Cabin pressure is displayed and monitored in concert with O₂, as is temperature and humidity.

Viewing: Three viewports all forward on bow. TV mounted externally with internal recorder. Hand-held TV available.

Manipulators: Two carried; a PHA and a heavy lift. The PHA has six degrees-of-freedom, 150 (68kg) lift capacity, scissors-type claw, claw jettisonable. Heavy duty manipulator: three degrees-of-freedom, 2,000 lbs (907kg) lift capacity, opposable "C" shaped-type claw, jettisonable.

Lift Point(s): There are five points to which the submersible can be lifted; one is primary and four are secondary. Primary: A standard 15 ton (13.6t) lift hook mounted on a swivel immediately aft of sail. Hook folds into sail to avoid entanglement while diving. Secondary: One at each corner of main frame (used to secure vehicle onboard) each consisting of a 7/8 in. (2.2cm) diam. bar steel with a hemispherical opening divided into a 2 in. (5.0cm) by 2 5/8 in. (6.6cm) rectangular opening.

Lighting (underwater): Two, 1,000 w, tungsten iodide lights on bow; two, 500 w quartz iodide, one, 250 w thallium iodide.

Life Jackets: Three, inflatable.

Distress Rockets: Six parachute-type flares in hull.

Surface Lights: One xenon, white flashing lights, 36 in. (91cm) above water surface, self-powered with a flash rate of once every second.

Fire Extinguisher: One, dry chemical.

Emergency Food & Water: Sufficient for nine man days. Three "space" blankets and two "Floater" suits and thermal protection, first aid kit also carried.

Surface Communications: One VHF transceiver operating off main battery and emergency gel cell in-hull.

Sub-Surface Communications: One underwater telephone operating on 8.0875 kHz and 27 kHz with an upward and downward-looking transducer. Operates off both the main battery and an emergency power supply. Pinging mode (8 & 27 kHz).

Surface Homing Devices: A hand-held, aircraft-type radio beacon is carried in pressure hull. It is self-powered, 48 hrs duration and transmits on 121.5 and 243.0 MHz. An RDF beacon in sail (27.095 MHz) can be used to locate sub from support craft.

Sonars: Transponder: self-powered, transmits or can be interrogated on 23, 24, 26, 27 kHz. Scanning sonar: Wesmar SS140 Sea Scope, range: 1,000 (3,280 ft) tiltable, 15 degrees upward and 90 degrees downward from the horizontal, operates on 160 kHz. Sail-mounted, 45 kHz pinger operates off main batteries SS140 capable of transponder integration 25 kHz out, 160 kHz in.

Emergency Buoyancy: Manually droppable weight: 385 lbs (175kg); thrusters droppable; 58 lbs (26kg) each; PHA claw droppable: 17 lbs (7.7kg); Heavy Duty manipulator claw droppable: 65 lbs (29kg).

Emergency Breathing: Six Drager closed-circuit emergency breathing devices are carried, each provides 30 minutes life support minimum.

Communications Procedure: Check with surface every 15 minutes, dive aborted after 30 minutes if no contact.

Egress Procedure (underwater): Pressure hull can be flooded and high pressure air introduced to equalize internal pressure to ambient. Hatch is opened and life jackets donned to assist ascent. Procedure is a "last ditch" resort and limited to 200 ft (61m) depth.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: M/V PANDORA II

Owner: Department of the Environment
Ottawa, Canada

Operator: Department of the Environment
Pacific Region
512-1230 Government St.
V8W1Y4
Canada

Builder: International Hydrodynamics, Ltd.
Vancouver, B.C.

Point-of-Contact: Mr. I. Sanderson
Address same as owner
Telephone: (604) 656-8332 (office ashore)
(604) 656-8241 (PANDORA II)
Cable: 0448137

PISCES V & VI

CHARACTERISTICS

Length.....	20 ft (6.1m)	Hatch Diameter	19.4 in. (49.3cm)
Beam.....	10 ft (3.0m)	Life Support Duration.....	168 man hrs
Height.....	12 ft (3.6m)	Total Power.....	39 kWh
Draft.....	8.75 ft (2.7m)	Speed: Cruise (kts/hrs)..	0.5/10
Weight.....	10.9 tons (9.8t)	Max (kts/hrs).....	2/4
Operating Depth.....	6,600 ft (2,012m)	Crew: Pilot(s)	1
Collapse Depth (P. V).....	9,000 ft (2,743m)	Observer(s).....	2
(P. VI).....	10,000 ft (3048m)	Payload.....	1,000 lbs (455kg)
Launch Date (P. V).....	1973	Color	White
(P. VI).....	1976		

Pressure Hull: Spherical shape, composed of HY-100 steel 80 in. (2.03m) diameter, 1.038 in. (2.54cm) thick.

Power Source: Lead acid batteries, 120 V 330 amp-hr, pressure compensated.

Maneuvering Control: Two, five hp each, reversible thrusters are mounted p/s amidships. Thrusters are rotatable 90 degrees upward to 30 degrees downward from the horizontal.

Life Support: Five flasks of O₂ are carried, three are located within the pressure hull and hold 64 ft³ (1.8m³) each, two are located externally and hold 70 ft³ (2m³) each.

CO₂ is removed by scrubbing cabin air through LiOH. Monitors for O₂, CO₂, temperature, humidity and pressure, monitoring of these properties is approximately every 15 minutes.

Viewing: Three viewports on bow, all look forward. Television mounted externally on training mechanism.

Manipulator: Two, both hydraulically-powered and both have jettisonable claw. One has two degrees-of-freedom and is designed for 2,000 lb (906kg) grasping capacity used for torpedo recovery. The second has six degrees-of-freedom and is designed for 200 lb (907 kg) grasping capacity. The heavy lift manipulator has an opposing "C"-shaped claw; the lighter lift manipulator has a parallel jaws-type claw.

Lift Point(s): A standard 15 ton (13.6t) hook mounted on a swivel immediately aft of the sail.

Life Jackets: Three, inflatable

Surface Lights: Flashing white xenon light, 3 ft (0.9m) above water surface, flash rate 1/3 seconds, self powered. Duration: 36 hours.

Fire Extinguisher(s): Two

Emergency Food and Water: Equal to duration of life support. Five pints (1.3 l.) of water is carried for each occupant. Food consists of life boat type C rations. Protective (thermal) clothing and blankets.

Surface Communications: VHF transceiver operates on 157.65, 156.80 and 156.65 MHz. Range approximately 3 nm (5.6 km). Emergency power supply provided.

Sub-Surface Communications: One underwater telephone is carried and operates off the main batteries. It transmits and receives on either 10 or 27 kHz.

Sonars: A Wesmar (Mod. SS140S) scanning sonar is mounted on the bow and can scan a 180 degree forward sector. Display is PPI and audio. Pinger: The underwater telephone can act as a pinger with a one second rep rate on 27 kHz and may be self-powered or operate off the main batteries for a duration of three months. An AMF (Mod. 365) acoustic beacon is carried which may be activated at selectable pulses (10 to 100 second intervals) by a self-contained clock. The beacon clock can be synchronized with a shipboard clock to obtain slant range and (with suitable shipboard receivers) relative bearing. The beacon transmits on 10 kHz, is self-powered and will operate for six months at a 30 second repetition rate.

Directional Antennae: A pinger/receiver (Hydro Products) is mounted on the bow to receive a 27 kHz pulse. It is trained by rotating the submersible and has an audio display.

Marker Buoys: Emergency buoy consists of a 10 in. (25cm) diam., international orange Grimsby float which is manually released (through hydraulics) and tethered to 2,000 feet (609m) of 0.25 in. (0.6cm) diam. nylon line.

Jettisonable Components: Propulsion motors (two each), 450 lbs (204kg) weight, manipulator claws 120 lbs (54kg). Total weight approximately 800 lbs (364kg). Droppable weight 400 lbs (181kg).

Emergency Breathing: Three (Draeger) self-contained, oxygen rebreathers provide 45 minutes for each occupant.

Communications Procedure: Surface check every 15 minutes, dive aborted if communications not established within 30 minutes.

System Readiness: Operational.

Classification/Certification: ABS

Support Ship: P. V: Ship of Opportunity

P. VI: Drill ship DISCOVERER SEVEN SEAS

Owner: Hyco Subsea Ltd.

P.O. Box 1059

Station "A"

Vancouver, B.C.

Canada

Operator: Same as above

Builder: International Hydrodynamics Ltd.

North Vancouver, B.C.

Point-of-Contact: Mr. Dave Vervaet

Hyco Subsea Ltd.

P.O. Box 1059

Station "A"

Vancouver, B.C.

Canada

Telephone: (604) 929-2391

(604) 688-8607

Telex: 04-55465

Mr. Bill Faulkner

or Hyco Subsea Inc.

4800 W 34th St B-7

Houston, Texas 77092

Telephone: (713) 688-6382

Telex: 79-0169

PISCES VII & XI

CHARACTERISTICS

Length.....	19.25 ft (5.85m)	Hatch Diameter.....	19.4 in. (49.3cm)
Beam.....	10 ft (3.05m)	Life Support Duration....	216 man hrs
Height.....	12 ft (3.65m)	Total Power.....	46.2 kWh
Draft.....	8.75 ft (2.7m)	Speed: Cruise (kts/hrs)..	0.5/10
Weight (dry)....	11.75 tons (10.7t)	Max (kts/hrs)....	2/4
Operating Depth..	6,600 ft (2,012m)	Crew: Pilot(s).....	2
Collapse Depth...	10,000 ft (3,048m)	Observer(s).....	1
Launch Date.....	1975 (P. VII)	Payload.....	1,500 lbs (679kg)
	1976 (P. XI)	Color.....	Red: Sail
			White: Fairing
			Green: Pressure Hull

Pressure Hull: Spherical shape, 80 in. (2.03m) OD, HY-100 steel, 1.038 in. (2.52cm) thick.

Power Source: Lead acid batteries, pressure compensated, provides 350 amp-hr at 120 VDC and 125 amp-hr at 12 and 24 VDC. Converter 120 D.C. - 220 A.C.

Maneuvering Control: Two thrusters mounted p/s amidships, each is five hp, reversible and has continuously variable speed control. Both are jettisonable and can be rotated 25 degrees upward from the horizontal and 95 degrees downward from the horizontal.

Pitch/Trim: Sea water can be pumped forward or aft to provide for ± 10 to ± 30 degrees bow angle.

Life Support: Five flasks of O₂ 10.5 qts (ten l.) capacity each bled continuously into hull. CO₂ is removed by scrubbing through CaOH for a period of 10-15 minutes every 30 minutes. Every 30 minutes the following properties are monitored: O₂, CO₂, temperature, humidity and pressure. Both O₂ and CO₂ monitors have backup monitoring devices.

Viewing: Three viewports on the bow. External TV and recorder.

Manipulators: Two manipulators, a PHA and a heavy lift. The PHA has six degrees-of-freedom, 115 lbs (52kg) lift capacity and a scissors-type claw, 7 in. (0.18cm) grip which is jettisonable from the wrist. The heavy lift manipulator has three degrees-of-freedom, 1,500 lbs (675kg) grasping capacity and a jettisonable, 28 in. (0.71m) "C" shaped claw when opened.

Lift Point: A 1 in. (2.54cm) thick standard shackle constitutes the main lift point. This may change when the vehicles become operational.

External Lighting: Two quartz iodide, 100 w each, mounted forward.

Life Jackets: Three, inflatable

Distress Rockets: Will have; undecided at time of survey.

Fire Extinguishers: One, dry chemical

Emergency Food & Water: Food and water carried equal to life support. Food will be space craft-type rations; five l. (5.3 qts) of water. Protective thermal clothing is being investigated.

Medical Supplies: First aid kit

Surface Communications: CB and VHF transceivers, operate off main batteries, two to three nm (3.7-6.5km) range.

Sub-Surface Communications: One underwater telephone (Mesotech Mfg.), ten and 18 kHz, powered off main batteries.

Surface Homing Devices: Radio transponder provides range and bearing to support ship, self-powered, 64 hrs duration.

Sonars: Scanning Sonar (Wesmar Mod. SS140S) 160 kHz, 1600 ft (500m) range, 360 degree scan, CRT display, beam width seven degrees, transducer tilt adjustable from the horizontal plane four degrees upward to 90 degrees downward.

Marker Buoys: Syntactic foam segments are shaped into a rectangular block approximately 3 ft x 3 ft x 2 ft (91cm x 91cm x 61cm) which is stored topside over a circular drum. The block is hydraulically-released and upon ascent reels out 5/16 in. (0.8cm) diam. "Phillystran" line which has a breaking strength of six tons (5.4t) and is 2km (1.1nm) long. The buoy is red and white striped and the Phillystran line can be directly used to retrieve the vehicle. The original Hyco design allows for attachment of a radio transmitter, flashing light atop the buoy and an acoustic pinger on the bottom (underwater) of the buoy for surface location.

Jettisonable Components: One 400 lb (181kg) lead weight, propulsion motors, claws of both manipulators. Total weight droppable: 596 lbs (270kg).

Emergency Breathing: Three, closed circuit (Drager Mfg.) breathing devices providing 30 minutes/occupant.

Communications Procedure: Surface check every 30 minutes, abort dive if no contact is made after 60 minutes.

System Readiness: PISCES VII is installed on board research ship DMITRY MENDELEEV

Classification/Certification: ABS

Support Ship: R/V AKADEMIK KURCHATOV and DMITRI MENDELEEV

Owner: Academy of Sciences USSR
Moscow

Operator: P.P. Shirshov Institute of Oceanology
Academy of Sciences USSR
1 Letnaya St., Moscow 109387
USSR

Builder: International Hydrodynamics Ltd.
Vancouver, B.C.

Point-of-Contact: Mr. A. Monin, Director
Institute of Oceanology USSR
Address same as operator
Telephone: 233-55-76
Cable: G-387 OCEANOLOGIYA

P8 & P10

CHARACTERISTICS:

Length.....	20.5 ft (6.2m)	Hatch Diameter.....	20.9 in. (53cm)
Beam.....	10.8 ft (3.3m)	Life Support Duration.....	336 man hours
Height.....	10.6 ft (3.2m)	Total Power.....	40 kWh
Draft.....	N/A	Speed: Cruise (kts/hrs)....	N/A
Weight (dry).....	11.75 tons (10.7t)	Max (kts/hrs).....	2/N/A
Operating Depth.....	3280 ft (1000m)	Crew: Pilot(s).....	1
Collapse Depth.....	4921 ft (1500m)	Observer(s).....	1
Launch Date.....	PVIII - 1975	Payload.....	1500 lbs (680kg)
	PX - 1975	Color.....	White

Pressure Hull: Spherical shape, Corten B steel 6.7 ft (2.04m) OD.

Power Source: Lead acid batteries, pressure-compensated, divided into main and auxiliary. Main: 120V-235AH @ 5 hr rate. Auxiliary: 24V - 180AH @ 5 hr rate, 12V - 120AH @ 5 hr rate. Emergency power in pressure hull provides 12V at 20 amp-hr.

Maneuvering Control: Two propulsion units consisting of two, reversible, screw-type propellers mounted p/s, each unit is driven by a five hp motor.

Pitch/Trim: Water is transferred forward or aft to provide approximately $\pm 15^\circ$ bow angle.

Life Support: Five flasks of O_2 are carried, three are located in the pressure hull and hold 64 ft³ (1.8m³) each, two are located externally and hold 70 ft³ (2m³) each. CO_2 is removed by scrubbing through LiOH. Monitors for O_2 , CO_2 , temperature, humidity and pressure; monitoring of these properties is approximately every 15 minutes.

Viewing: Three view ports on bow, all look forward. Television mounted externally on pan and tiltable mechanism.

Manipulators: Two, hydraulically-powered, jettisonable claws. One has two degrees-of-freedom and is designed for 2000 lbs (907.kg) grasping. The heavy lift manipulator has an opposing 'C' shaped claw; the lighter lift manipulator has a parallel jaws-type claw.

Lift Points: A flat, steel plate shaped into a 'Rams Horns' configuration. One circular hole in the plate, approximately 2.5 in. (6.4cm) ID, plus 2 emergency lift points.

External Lighting: Three, 1000w each, quartz iodide lights mounted forward above viewports.

Life Jackets: Two, inflatable.

Surface Lights: Flashing white light, 3 ft (0.9m) above water surface, one flash every three seconds, self-powered.

Fire Extinguisher: Two - Halon 1301.

Medical Supplies: First aid kit.

Surface Communications: VHF transceiver operated on 157.65, 156.80 and 156.65 MHz. Range approximately three nm (5.6km) emergency power supply provided.

Sub-Surface Communications: One underwater telephone (Mesotech 703) transmitting on 10 or 27 kHz. Four transducers, two face upward and two down, emergency power provided.

Sonars: Scanning sonar (Wesmar SS140S) trainable ± 90 degrees p/s and transmitting on 160 kHz. Pinger mode in underwater telephone, emits on 10 or 27 kHz, one ping every three seconds. Transponder (AMF Mfg.) receiving on 10 kHz, responds on 11 kHz. Directional Hydrophone (Helle Mfg.) receiving on 27 kHz.

Marker Buoys: One, red, 10 in. (25.4cm) diameter sphere attached to 4,000 ft (1219m) of line.

Jettisonable Components: Propulsion motors (two each), 180 lbs (82kg) manipulator claws 50 lbs (23kg), dropweight 350 lbs (159kg).

Emergency Breathing: Three, (Emox Mfg.), closed-circuit oxygen rebreathers provide 45 minutes for each occupant.

Communications Procedure: Surface check every 15 minutes, dive aborted if communications not established after 30 minutes.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: VICKERS series

Owner: Vickers Oceanics Ltd.

P. O. Box 8
Barrow-in-Furness, Cumbria
England

Operator: Vickers Oceanics Ltd.

P. O. Box 215
Leith Docks
Edinburgh EH6 6ND
Scotland

Builder: International Hydrodynamics Ltd.

N. Vancouver, B.C.
Canada

Point-of-Contact: Base Duty Officer

Vickers Oceanics Ltd.
(Address same as operator)
Telephone: 031 554 4411 (Leith)
Telex: 72248

PS-2 (PC8)

CHARACTERISTICS

Length.....	19.5 ft (5.9m)	Hatch Diameter.....	22 in. (55.8cm)
Beam.....	6 ft (1.8m)	Life Support Duration.....	288 man hrs
Height.....	7 ft (2.1m)	Total Power.....	26kWh
Draft.....	5 ft (1.5m)	Speed: Cruise (kts/hrs)...	1/8
Weight (dry).....	6.5 tons (5.9t)	Max (kts/hrs).....	3/1
Operating Depth.....	1,025 ft (312m)	Crew: Pilot(s).....	2
Collapse Depth.....	2,000 ft (610m)	Observer(s).....	1
Launch Date.....	1972	Payload.....	400 lbs (181kg)
		Color.....	Yellow

Pressure Hull: Cylindrical with conical stern and hemispherical bow end caps. Composed of A-516-GR70 steel.

Power Source: Lead acid batteries carried in two pressure-resistant pods. Twenty four batteries total supplying 24 VDC at 92 amp-hrs rate. Electric power package (115kWh) available.

Maneuvering Control: Main forward propulsion is provided by a fixed, reversible, stern-mounted propeller powered by a 7.5 hp motor. Two, reversible thrusters provide vertical propulsion. Dive plane and rudder assist in providing underway control.

Life Support: Four O₂ tanks are carried externally and hold 1.4 ft³ (40 l.) each at 2,400 psig (169kg/cm³). CO₂ is removed by scrubbing through LiOH. Monitors for O₂, CO₂, temperature, humidity and pressure. All properties are checked once every 15 minutes.

Viewing: One 114 degree acrylic plastic bow dome. Eight viewports are located in the conning tower and hatch cover. External television camera on a pan and tilt mechanism.

Manipulator: One, hydraulically-powered, six degrees-of-freedom, parallel jaws type claw, 6 ft (1.8m) long, not jettisonable, various hand hools.

Lift Points: A steel plate located topside immediately aft of the conning tower is perforated by three holes approximately 1 in. (2.54cm) ID, the plate is 2 in. (5cm) thick.

External Lighting: Two, 1,000 w each, quartz iodide lights are mounted p/s forward on the bow.

Life Jackets: Two, inflatable

Distress Rockets: Ten white and ten red, 20mm rockets are carried inside the pressure hull and fired through the opened hatch from a Very pistol.

Surface Lights: One, white, self-powered, strobe light mounted 2 ft (60cm) above the water surface with a duration exceeding 12 hours.

Fire Extinguisher: One, dry chemical

Emergency Food & Water: Twenty liters (42 pts) of potable water. Chocolate, dextrose and ship's biscuit. Equivalent to life support duration. Sweaters, caps and tights also carried.

Medical Supplies: First aid kit, anti-burn cream, methedryne pills.

Surface Communications: One, VHF transceiver

Sub-Surface Communications: One underwater telephone (Helle Mod. UT-01-PVC), 27 kHz, one transducer mounted topside.

Sonars: Scanning sonar (Wesmar Mod. SS160S), 160 kHz, 360 degree scan, PPI display.

Pinger (Wesmar Mfg.) included as component of scanning sonar.

Marker Buoy: One carried, no details available.

Jettisonable Components: One 250 lb (114kg) weight is mechanically released.

Emergency Breathing: Two open-circuit regulators drawing off water deballasting air are provided. Approximately two hours is available to each occupant.

Communications Procedure: Check with surface once every 15 minutes, abort dive if no surface contact within 30 minutes.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: M/V CAPALONGA

Owner: Sub Sea Oil Services

Via S. Vittore

45 Milano

Italy

Operator: Same as owner

Builder: Perry Submarine Builders, Inc.

Riviera Beach, Florida

Point-of-Contact: Ing. G. Santi, Gen. Mgr.

Address same as owner

Telephone: 02-4873141

Cable: SUBSEA MILAN

Telex: 39204

PX-28

CHARACTERISTICS

Length.....7.5m (24.6 ft)	Hatch Diameter.....NA
Beam.....2.6m (8.5 ft)	Life Support Duration.....NA
Height.....2.25m (7.4 ft)	Total Power.....65 KWH
Draft.....NA	Speed: Cruise.....NA
Weight.....10t (11 tons)	Max.....NA
Operating Depth.....500m (1,640 ft)	Crew: Pilot(s).....1
Collapse Depth.....NA	Observer(s).....2
Launch Date.....1978 planned	Payload.....500kg (1,102 lbs)
	Color.....NA

Pressure Hull: Cylindrical shape, 1.4m (4.6 ft) OD, closed by two hemispheres.

Power Source: Lead-acid batteries in pressure-resistant pods.

Maneuvering Control: One main propulsor, 13 hp. One vertical and one lateral thruster, each 1 hp. Two directional thrusters mounted port/starboard amidships, 1 hp each.

Viewing: Plastic bow dome 1m (3.28 ft) diameter. One hemispheric plastic hatch cover 0.6m (2 ft) diameter.

Manipulators: Two

Further details not available. Vehicle in initial stage of construction.

Classification: ABS

Owner: Foundation Pour L'Etude et la Protection de La Mer et des Lacs
Place d'Armes
1096 Cully
Switzerland

Operator: Same as Owner

Builder: Viovanola Bros.
Monthey, Switzerland

Point-of-Contact: Dr. Jacques Piccard
(Address same as Owner)
Telephone: 021 99 25 65
Telex: 24560

SDL-1

CHARACTERISTICS

Length.....	20 ft (6.1m)	Hatch Diameter.....	Control 25 in. (63.5cm) LCC 22.75 in. (57.8cm)
Beam.....	10 ft (3.0m)	Life Support Duration.....	204 man hrs
Height.....	12 ft (3.7m)	Total Power.....	57 kWh
Draft.....	9 ft (2.7m)	Speed: Cruise (kts/hrs)...	1/8
Weight (dry).....	13 tons (11.8t)	Max (kts/hrs).....	1.5/5
Operating Depth...	2,000 ft (610m)	Crew: Pilot.....	1
Collapse Depth...	4,000 ft (1,220m)	Co-Pilot.....	1
Launch Date.....	1970	Observer(s).....	1
		Diver(s).....	3
		Payload.....	2,000 lbs (907kg)
		Color.....	White with international orange sail

Pressure Hull: Two HY-100 steel spheres connected by a cylindrical tunnel to form a forward control sphere and an after LOS. The control sphere is 7 ft (2.1m) OD and 0.526 in. (1.34cm) thick; the LOS is 65 in. (1.65m) OD and 0.414 in. (1.05cm) thick and the connecting cylinder is 25 in. (63.5cm) ID, 71 in. (180cm) long and 0.52 in. (1.34cm) thick.

Power Source: Lead acid batteries, pressure-compensated, supply 128, 28 and 12 volts from three separate banks each rated at 340 amp-hrs. Emergency power for the underwater telephone is supplied by two 135 V nickel cadmium batteries inside the pressure hull.

Maneuvering Control: Two, five hp, p/s mounted, reversible, variable speed thrusters provide forward and lateral propulsion. Thrusters are fixed in the horizontal plane, but may be operated independently to provide lateral maneuvering.

Pitch/Trim: Bow angles of ± 15 degrees can be obtained by moving the 12/28 volt battery box forward or aft.

Life Support: O₂ is carried externally in one 613 ft³ (17m³) cylinder at 3,000 psi (212kg/cm²) and internally in two 60 ft³ (1.7m³) cylinders. CO₂ is removed by scrubbing through Dragorsorb, one scrubber in control sphere, one in LOS. Monitors for O₂, CO₂, temperature and pressure; these properties are checked every 20 minutes.

Viewing: Ten viewports total, all are located in the control sphere.

Manipulators: Two, both hydraulically-powered, both have jettisonable claws. One (called the PHA) is 5.5 ft (1.7m) long, has six degrees-of-freedom, a parallel jaws-type claw of 4 in. (10cm) maximum opening and a grip force of 1,000 lbs (452kg). The other (called the Torpedo claw) is 36 in. (91cm) long, has three degrees-of-freedom, two opposing C-type claws of 10 in. (25cm) and 8 in. (20cm) ID, and a grip force of 2,000 lbs (904kg).

Lift Points: The main lift point is a 1.5 in. (3.8cm) thick standard shackle with major and minor IDs of 5.5 in. (13.9cm) and 3.5 in. (8.9cm), respectively. The shackle is located immediately aft of the sail hatch opening, it is held in an upright position while submerged. One additional lift point is located on each corner of the supporting framework, (four points total) these are 0.5 in. (1.27cm) diameter circular holes drilled through 3/16 in. (0.5cm) thick steel plates. The four additional lift points cannot support the entire vehicle weight, but can be used to lift it to some depth near the surface.

External Lighting: Four lights total, all are 1,000 w, quartz iodide. Three illuminate the forward viewing area, one illuminates the area below the LOS.

Life Jackets: Six, inflatable

Surface Lights: One, flashing white, (OAR Mod. SF-50-1-100), self-powered, 100 hrs duration at rep. rate of one flash/second, 3 ft (0.9m) above water level.

Fire extinguisher: Two, dry chemical

Emergency Food & Water: Survival candies carried which provide a food supply equal to life support duration. Forty eight 12 oz (0.35 l.) cans of water. Sleeping bags carried for each occupant.

Medical Supplies: First aid kit

Surface Communications: VHF transceiver (Motorola HT220), 5 nm (9.3km) range, self-powered, four channels (156.700, 156.750, 156.800, 156.850).

Sub-Surface Communications: One underwater telephone (Ametek Straza Mod. ATM-504A), 8.0875 kHz, CW, operates off main or emergency power. Two transducers, one is mounted on the sail and one on the keel.

Sonars: Scanning sonar (Wesmar SS140S), 160 kHz, PPI and audio, 360 degree scan, can scan from 4 degrees above the horizontal to 90 degrees below the horizontal.

Pinger (Helle Mfg.): 27 kHz, self-powered, duration depends upon rep. rate which is selectable, salt water activated. A synchronous pinger (AMF Mod. 360 Acoustic Beacon), transmits on 11 kHz, self-powered.

Marker Buoy: None.

Jettisonable Components: Two weights each weighing 350 lbs (158kg), manipulator arms and thrusters.

Emergency Breathing: Six SCUBA regulators connected to an Emergency Breathing Air Cylinder provide a minimum of 100 minutes for each occupant. Face masks are provided.

Egress Procedure: Routine egress from LOS and CS.

Communications Procedure: Check with surface every 20 minutes, dive aborted if no contact is established within 25 minutes.

System Readiness: Operational

Classification/Certification: ABS and to Canadian Armed Forces standards

Support Ship: HMCS GRANBY (ASXL-20)

Owner: Canadian Armed Forces

Operator: Commanding Officer
HMCS COMDRANT
FMO Halifax, N.S.
B3K2X0
Canada

Builder: International Hydrodynamics, Ltd.
No. Vancouver, B.C.
Canada

Point-of-Contact: Same as operator

SEA CLIFF & TURTLE

CHARACTERISTICS

Length.....	26 ft (7.9m)	Hatch Diameter.....	19.75 in. (50.2cm)
Beam.....	12 ft (3.7m)	Life Support Duration.....	111 man hrs
Height.....	12 ft (3.7m)	Total Power.....	30 kWh
Draft.....	7.5 ft (2.3m)	Speed: Cruise (kts/hrs).....	0.5/8
Weight (dry).....	25 tons (23t)	Max (kts/hrs).....	2.5/2
Operating Depth..	6,500 ft (1,981m)	Crew: Operator(s).....	2
Collapse Depth...	9,750 ft (2,972m)	Observer(s).....	1
Launch Date.....	1968	Payload.....	NA
		Color.....	White with orange sail

Pressure Hull: Spherical shape, HY-100 steel, 7 ft (2.1m) OD, 1.5 in. (3.8cm) thick.
Power Source: Lead acid batteries, pressure compensated, 30 and 60 VDC, each rated at 500 amp-hrs. Emergency power consists of two silver zinc batteries (12 amp-hrs each) inside the hull which provide power for communications, CO₂ scrubber, jettisoning and internal lights.

Maneuvering Control: One propeller which is stern-mounted, reversible and trainable 45 degrees p/s provides main propulsion. Two thrusters mounted p/s amidships are trainable 360 degrees in the vertical and reversible (about 600 lbs (270kg) lift) four hp each.

Pitch/Trim: By transferring mercury forward or aft TURTLE can obtain bow angles of ± 10 degrees; SEA CLIFF ± 14 degrees.

Life Support: O₂ is carried inside the pressure hull in two flasks. One (for routine use) has a volume of 0.6ft³ (0.02m³) and is charged to 3,000 psi (210kg/cm²), the second (for emergency use) has a volume of 175 in.³ (2,868cm³) and is charged to 2,015 psi (142kg/cm²). CO₂ is routinely removed by scrubbing through LiOH. Baralyme is used in the emergency system. O₂, CO₂, temperature, humidity and pressure are monitored continuously and recorded once every 60 minutes. Backup O₂ and CO₂ monitors (Beckman and Drager, respectively) are carried.

Viewing: Five viewports total, four large and one small. The large viewports are oriented to look forward, vertically downward and p/s of the forward looking port. The small viewport is located in the hatch cover.

Manipulator(s): Two, hydraulically-powered, six degrees-of-freedom with wrist rotate and linear extension, various claw types (scissors, parallel jaws, cable cutters), jettisonable.

Lift Point: One consisting of a 1.75 in. thick (4.4cm) wire strap coiled in the sail area which is attached to the pressure sphere lift points and protrudes some 4 in. (10cm) above sail. The strap can support the entire weight of the forebody.

External Lighting: Four thallium iodide lights, one is on the bow, one on the pan and tilt and two are on the sponsons, 250 watts each. One bow-mounted quartz iodide.

Life Jackets: Three, inflatable.

Radar Reflector: One, inside sphere, expandable wire mesh, circular shape.

Surface Lights: One, flashing white, one flash every four seconds, self-powered. Approximately 4 ft (1.2m) above water surface, pressure-activated. Also carries a battery-powered fog horn.

Fire Extinguisher: One, CO₂.

Emergency Food & Water: Whatever is onboard for daily dive consumption.

Surface Communications: Two, one radio transceiver, VHF, 5 channel, 20 watt, 20 miles (37km) range. The second is self-powered and hand-carried.

Sub-Surface Communications: One (Straza 504 with TIPE option), 8.0875 kHz, CW (8.887 kHz). Two transducers, both topside, one transmits in a conical beam and one is omnidirectional.

Sonars: CTFM scanning sonar (Ametek/Straza Mod. 500), 87 to 72 kHz, CRT, 360 degrees scan. Echo sounder with upward and downward-looking transducers. TURTLE operates on 50 kHz with 1,200 ft (366m) range; SEA CLIFF operates on 23 kHz with 3,000 ft (914m) range. An AMF ATNAV is installed on the support ship.

Jettisonable Components: Manipulators, batteries, selected weights, and sphere.

Emergency Breathing: Three full face masks, closed-circuit, draws off emergency O₂ and scrubs through baralyme, 98 minutes per user.

Communications Procedure: Contact surface every 30 minutes, abort dive if no contact within 30 minutes.

System Readiness: Operational

Classification/Certification: Both are U.S. Navy certified

Support Ship: M/V MAXINE "D" and ships of opportunity

Owner: U.S. Navy

Operator: Submarine Development Group One
San Diego, CA 92132

Builder: Electric Boat Division
General Dynamics Corp.
Groton, Conn.

Point-of-Contact: Commander
Submarine Development Group One
San Diego, CA 92132
Telephone: (714) 225-6583

SEA EXPLORER

CHARACTERISTICS

Length.....	15 ft (4.6m)	Hatch Diameter.....	24 in. (61cm)
Beam.....	4.6 ft (1.4m)	Life Support Duration.....	48 man hrs
Height.....	5 ft (1.5m)	Total Power.....	12 kWh
Draft.....	2.6 ft (0.7m)	Speed: Cruise (kts/hrs)...	1.75/4
Weight (dry).....	2 tons (1.8t)	Max (kts/hrs).....	7/1
Operating Depth..	600 ft (183m)	Crew: Pilot(s).....	1
Collapse Depth...	2,000 ft (609m)	Observer(s).....	1
Launch Date.....	1970	Payload.....	300 lbs (136kg)
		Color.....	Yellow

Pressure Hull: Cylindrical shape with elliptical end caps composed of fiber-reinforced plastic 2 in. (5cm) thick.

Power Source: Lead acid batteries in pressure hull deliver 30 V at 420 amp-hr.

Maneuvering Control: One, stern-mounted, reversible and trainable (85 degrees p/s) main propeller and one bow thruster capable of 360 degree rotation in the vertical plane. Both propellers are hydraulically-powered off a ten hp electric pump.

Life Support: Eighty ft³ (2.26m³) of O₂ at 2,000 psi (140kg/cm²) carried inside pressure hull which is added to atmosphere as needed. CO₂ scrubber uses soda-sorb. Monitor for cabin pressure only (barometer) which is used to infer amount of O₂ in hull.

Viewing: Nineteen viewports located throughout vehicle.

Lift Points: Two, one located on port side of after conning tower and one located on starboard side of forward conning tower. Both are circular in shape; composed of 0.75 in. (1.9cm) thick stainless steel and 1.75 in. (4.4cm) ID. Either attachment is capable of sustaining entire vehicle weight.

Lighting (underwater): Six lights total; all are incandescent aircraft lights and operate off 30 VDC. Two are 250 w, three are 450 w and one is 150 w.

Life Jackets: Two, inflatable.

Surface Lights: Two aircraft lights on the conning tower can be turned on and off intermittantly to assist in location.

Sub-Surface Communications: A sound-powered telephone is used to communicate with the surface. Dive is aborted if communications are lost. Occasionally uses a wireless telephone (Helle Eng. Co.) which operates off main battery on 27 kHz.

Marker Buoys: Four. Extruded from a tube by compressed air. Not attached to vehicle. Each buoy is composed of a 6 lb (2.7kg) lead weight, a 40 lb (18kg) test nylon string and an orange-colored, cylindrical buoy 6 in. (15.2cm) long and 4 in. (10.2cm) diam.

Jettisonable Components: The keel can be manually dropped to provide 625 lbs (283kg) positive buoyancy. MBTs can be blown at max. operating depth to provide 800 lbs (362kg) positive buoyancy.

Emergency Breathing: Each life jacket is equipped with a 2 ft³ (.05m³) capacity flask of compressed air. The compressed air is used to inflate jacket, but can also be used as emergency breathing through a mouthpiece on each jacket. Approximately ten minutes of breathing time is obtained from each jacket.

Egress Procedure (underwater): Hull can be flooded to allow personnel to exit underwater.

System Readiness: Operational

Classification/Certification: None

Support Ship: Ship of opportunity

Owner: Sea-Line, Inc.

3325 227th St., S.W.

Brier, WA. 98036

Operator: Same as above

Builder: Same as above

Point-of-Contact: R.J. Lavingueure

Address same as above

Telephone: (206) 778-3917

SEA OTTER

CHARACTERISTICS

Length.....	13.5 ft (4.1m)	Hatch Diameter.....	19 in. (48.3cm)
Beam.....	5 ft (1.5m)	Life Support Duration.....	200 man hrs
Height.....	7.2 ft (2.3m)	Total Power.....	13.8 kWh
Draft.....	5.5 ft (1.7m)	Speed: Cruise (kts/hrs)...	1/6
Weight (dry).....	3.2 tons (2.9t)	Max (kts/hrs).....	3/1.5
Operating Depth..	1,500 ft (457m)	Crew: Pilot(s).....	1
Collapse Depth...	3,650 ft (1,113m)	Observer(s).....	2
Launch Date.....	1971	Payload.....	500 lbs (249kg)
		Color.....	Yellow

Pressure Hull: Two, 0.625 in. (1.6cm) thick, mild steel, hemispheric sections are welded to the ends of a 0.75 in. (1.9cm) thick, 57.0 in. (145cm) long, 48.0 in. (122cm) wide, mild steel cylinder, with a 0.75 in. (1.9cm) thick, 19.0 in. (48cm) diameter hatch tower welded to the pressure hull.

Power Source: Twelve 2-volt lead acid batteries provide 13.8 kWh. They are located inside the pressure hull and are equipped with catalyzers to eliminate hydrogen.

Maneuvering Control: A three hp DC motor drives a trainable, stern-mounted propeller for main propulsion. Two 0.5 hp DC horizontal thrusters, located fore and aft, provide steering. A hydraulically controlled rudder is mounted on the main thruster. A 0.5 hp vertical thruster is mounted forward.

Pitch/Trim: Bow angle of ± 15 degrees is attained by putting air or water in either the main or forward ballast tanks.

Life Support: Three 40 ft³ (1.1m³) tanks of oxygen carried inside hull is continuously bled into the hull. Scrubbing of CO₂ is accomplished by recirculating air through a 6.4 lb (2.9kg) lithium hydroxide cannister. CO₂ and atmospheric pressure are measured periodically.

Viewing: Four viewports forward on bow; two p/s viewports also forward. Three viewports are located in the hatch tower and one viewport is located in the hatch cover.

Manipulator(s): One, six degrees-of-freedom linear extension, not jettisonable, 50 lb (22kg) lift capacity, 62 in. (1.5m) total length. Dorrance type claw.

Lift Point(s): Two metal padeyes 5/8 in. (1.6cm) thick located forward and aft of conning tower with circular opening of 1 in. (2.5cm) diam. One padeye can lift entire vehicle.

Lighting (underwater): A total of six lights are carried on brow. They are quartz iodide, 250 w, air compensated (Ikelite Mfg.).

Life Jackets: Two, inflatable

Distress Flares: One day/night (red/white) hand-held flare carried in pressure hull. Whistle also carried by pilot

Fire Extinguisher: One, dry chemical

Emergency Food and Water: One gal. (3.8 l.) water, four day supply food (candy bars).

Medical Supplies: First aid kit.

Surface Communications: CB transceiver, 5 w, 23 channel (Johnson Messenger).

Sub-Surface Communications: Two underwater telephones. Primary system is 27 kHz (Helle Mod. 3600), powered off main battery. Transducer is mounted topside. Secondary system is 42 kHz, also powered off main battery (Aquasonics Mfg.).

Sonars: Pinger: One 27 kHz, 0.25 w, one ping/sec. rep. rate, powered off main batteries. Avoidance Sonar: One, forward looking transducer (echo sounder) powered off main battery (with recorder & visual display). Directional Antennae: One, bow-mounted, receives from 25 through 40 kHz, five degree wide 90 degree vertical beam.

Marker Buoys: An international orange, 8 in. (20cm) diam. plastic float is manually released to carry 2,000 ft (609m) of 3/16 in. (0.5cm) polypropylene line to the surface. An ice tong is slid down this line which attaches to a 25 ton (22.7t) capacity cable shackled to the hull. A retrieving line is attached to the ice tong.

Jettisonable Components: One manually droppable 180 lb (81.5kg) weight, MBT and trim tanks blowable at operating depth.

Emergency Breathing: Two scuba regulators draw off main ballasting air. Two face masks.

System Readiness: Operational

Classification/Certification: None

Support Ship: Ship of opportunity

Owner: Can-Dive Services, Ltd.

250 East Esplanade
No. Vancouver, B.C.
Canada VL7 1A3

Operator: Same as above

Builder: Arctic Marine, Ltd.

No. Vancouver, B.C.

Point-of-Contact: Mr. T.K. Thompson

P.O. Box 91056
West Vancouver, B.C.
Canada V7V 3P2
Telephone: (604) 926-3201

SEA RANGER

CHARACTERISTICS

Length.....17 ft (5.2m)	Hatch Diameter.....16.5 in. (42cm)
Beam.....8 ft (2.4m)	Life Support Duration.....240 man hrs
Height.....8 ft (2.4m)	Total Power.....43.5 kWh
Draft.....5 ft (1.5m)	Speed: Cruise (kts/hrs)..2/10
Weight (dry).....9.5 tons (8.6t)	Max (kts/hrs)....4/5
Operating Depth..600 ft (183m)	Crew: Pilot(s).....1
Collapse Depth...1,800 ft (549m)	Observer(s).....2
Launch Date.....1973	Payload.....2,000 lbs (906kg)
	Color.....White above waterline, blue below

Pressure Hull: Cylindrical shape with hemispherical end caps. Composed of 285 Grade C mild steel. Total length is 16 ft (4.9m), diam. 4 ft (1.2m), hull thickness is 0.5 in. (1.3cm).

Power Source: Lead acid batteries in a pressure-resistant pod provide 240 VDC, 180 amp-hr.

Maneuvering Control: Two, stern-mounted (p/s), fixed, reversible propellers and one reversible vertical thruster; both are hydraulically-powered and are driven by a 10 hp electric motor.

Pitch/Trim: Electric motor and hydraulic pump can be moved forward or aft to provide +20 degrees bow angle.

Life Support: Two oxygen flasks of 122 ft³ (3.4m³) capacity each at 2,200 psi (154kg/cm²) are carried, one inside hull (for emergency) and one outside (routine use). O₂ is bled continuously into hull at one l/man/hr. CO₂ scrubber compound is baralyme; 80 lbs (36kg) are carried on each dive. Monitors for O₂, temperature and pressure.

Viewing: Eleven viewports located in conning tower and bow.

Manipulator(s): Two, both located on bow. Largest is 7 ft (2.4m) long, has four degrees-of-freedom, a lifting capacity of 200 lbs (91kg) at full extension and a pincer-type claw of 12 in. (30cm) max. opening. Smaller is 30 in. (76cm) long, has two degrees-of-freedom, linear extension, a static lift capacity of 2,000 lbs (906kg) and a pincer-type claw of 12 in. (30cm) max. opening. Both manipulators are hydraulically-powered and jettisonable.

Lift Point: Consists of a circular steel plate 3.5 in. (8.9cm) ID, 1 in. (2.54cm) thick. The lift point is below the deck fairings and is covered by two metal plates when submerged.

Lighting (underwater): Two, 1,000 w, quartz iodide lights mounted on bow.

Life Jackets: Two, inflatable

Fire Extinguisher: One, dry chemical

Surface Communications: One, self-powered, CW, CB transceiver

Sub-Surface Communications: One underwater telephone, 27 kHz, CW, self-powered, transducer mounted topside. Communications check every 30 minutes, dive aborted if no contact within 60 minutes.

Jettisonable Components: Six droppable weights totaling 600 lbs (272kg). Entire undercarriage is held on by a steel cable which can be cut to release pressure hull and thereby allow it to surface.

Emergency Breathing: Four scuba regulators draw off O₂ tank located external to pressure hull. Approximately 30 minutes duration is provided each user.

Egress Procedure (underwater): Hull may be flooded to allow underwater egress.

System Readiness: Operational

Classification/Certification: None

Support Ship: Ship of opportunity

Owner: Verne Engineering, Inc.

33256 Kelly Rd.

Fraser, Mich. 48026

Operator: Same as above

Builder: Same as above

Point-of-Contact: Kevin Price or James LeBlanc

Verne Engineering, Inc.

(Address same as above)

Telephone: (313) 792-9670

SHELF DIVER

CHARACTERISTICS

Length.....7m (23 ft)	Hatch Diameter.....60cm (23.6 in.)
Beam.....1.5m (4.9 ft)	Life Support Duration.....216 man hrs
Height.....2.9m (9.5 ft)	Total Power.....38 kWh
Draft.....2.5m (8.2 ft)	Speed: Cruise (kts/hrs)..2/NA
Weight (dry).....9t (9.9 tons)	Max (kts/hrs)....3.5/NA
Operating Depth..244m (800 ft)	Crew: Pilot(s).....1
Collapse Depth...300m (984 ft)	Observer(s).....2
Launch Date.....1968	Payload.....80kg (177 lbs)
	Color.....Yellow

Pressure Hull: Two cylindrical, steel compartments 0.5 in. (1.3cm) thick, 54 in. (137cm) diameter with hemispherical end caps. The compartments are welded together to form a forward pilot's chamber and an after LOC. A 28 in. (71cm) OD, 19 in. (48cm) high steel conning tower is welded to the pilot's compartment.

Power Source: Lead acid batteries in a pressure resistant cylinder provide 120 V at 275 amp-hrs and 24 V at 243 amp-hrs. An emergency lead acid battery is carried inside the pressure hull which provides 24 V at 93 amp-hrs and 12 V at 35 amp-hrs. Emergency power is for surface and sub-surface communications.

Maneuvering Control: Main forward propulsion is provided by a stern-mounted, fixed, reversible ten hp propeller. Vertical and lateral movement is assisted by two, 1.5 hp bow and stern thrusters.

Pitch/Trim: Sea water can be pumped between two fwd/aft tanks or each tank can be differentially filled to obtain \pm angles on the bow.

Life Support: O₂ is carried externally in four tanks which hold a total of 338 ft³ (9.6m³) at 2,100 psi (147kg/cm²). CO₂ is removed by scrubbing cabin air through soda lime (IR 8). Monitors for O₂, CO₂ and pressure; these are measured by the pilot at opportune times.

Viewing: Twenty-three viewports total, 15 are in the pilot's sphere and LOC, eight are in the conning tower.

Manipulator: One, four degrees-of-freedom, hydraulically-powered, 1.5m (4.9 ft) long, parallel jaws-type claw, maximum lift 100kg (221 lbs), not jettisonable.

Lift Points: Two, topside, aft of conning tower. Each consists of an oval-shaped, 7.5cm (3 in.) thick, steel plate which rotates fwd/aft on a steel pin. The attachment point in each plate is a circular hole 60mm (2.4 in.) diameter.

External Lighting: Five units total, four are on the bow and one looks aft. Two are 1,000 w, two are 500 w and one is 250 w, all are quartz iodide.

Life Jackets: Five, inflatable

Distress Flares: One, white color

Surface Lights: One, flashing white, rep. rate once every second, 76cm (30 in.) above the water surface.

Fire Extinguisher: One dry chemical

Emergency Food & Water: Life raft type rations. Five l. (5.3 qts) of water.

Medical Supplies: First aid kit

Surface Communications: One, VHF transceiver, 27 MHz, five channel.

Sub-Surface Communications: One underwater telephone, 27 kHz, two transducers (one topside; one on keel).

Sonars: Scanning sonar (Wesmar): 160 kHz, 1,600 yds (488m) range. Pinger operates on 38 kHz, one month duration. Echo sounder operates on 125 kHz.

Marker Buoy: One, attached to after lift point consists of pressure-resistant cylinder, international orange, 80cm (31 in.) length, 40cm (16 in.) diam. and attached by 800m (2,624 ft) of 4mm (0.15 in.) diam. line to a 2m (6.6 ft) long 15 metric ton (18.4 ton) lift capacity cable. The buoy end of the steel cable is configured to accept a retrieving line which can be slid down the nylon line. Lift capacity of buoy is from 10kg (22 lbs) at operational depth, to 40kg (88 lbs) at surface.

Jettisonable Components: Battery pods are mechanically droppable and weigh 1,659 lbs (750kg) in air.

Emergency Breathing: Five closed-circuit (Fenzy Mfg.) units providing six hours duration for each occupant.

Communications Procedure: Check with surface every 30 minutes, abort dive if no contact established within 45 minutes.

System Readiness: Operational

Classification/Certification: According to French Navy standards

Support Ship: COMMANDANT ROBERT GIRAUD

Owner: French Navy

Operator: Commandant la Division
des Sous-Marins d'Intervention et du Bathyscaphe
du GISMER
83 800 Toulon Naval
France

Builder: Perry Submarine Builders
Riviera Beach, Fla.

Point-of-Contact: Capitaine de Corvette
(Address same as operator)
Telephone: (94) 926300 (Toulon)

SKADOC 1000

CHARACTERISTICS

Length.....	5.4m (17.7 ft)	Hatch Diameter.....	60cm (23.6 in.)
Beam.....	1.35m (4.4 ft)	Life Support Duration.....	144 man hrs
Height.....	2.15m (7.1 ft)	Total Power.....	16 kWh
Draft.....	1.5m (4.9 ft)	Speed: Cruise (kts/hrs)...	1.5/6
Weight (dry).....	3t (3.3 tons)	Max (kts/hrs).....	5/NA
Operating Depth..	305m (1,000 ft)	Crew: Pilot(s).....	1
Collapse Depth...	914m (3,000 ft)	Observer(s).....	1
Launch Date.....	1973	Payload.....	200kg (441 lbs)
		Color.....	Yellow

Pressure Hull: Cylindrical shape with hemispherical end caps, 3.2m (10.5 ft) length; 178cm (70 in.) OD and 11mm (0.4 in.) thick.

Power Source: Lead acid batteries (16) in pressure-resistant pods providing 24 VDC at 180 amp-hr.

Maneuvering Control: Static: One VBT of 202kg (447 lbs) capacity, pumped to fill and empty. Dynamic: One, stern-mounted, reversible screw-type propeller trainable 45 degrees p/s. One hydraulic jet thruster rotatable 360 degrees in the vertical mounted on bow to assist lateral motion.

Life Support: Two, ten l. (2.6 gal) capacity O₂ flasks carried inside pressure hull and continuously bled into cabin. CO₂ is removed by scrubbing through soda sorb. Monitors for O₂, CO₂, temperature, humidity, pressure. Check of each property every 15 minutes.

Viewing: Eight viewports total, four in bow and four girdling conning tower. TV with recorder inside pressure hull.

Lift Points: Standard metal lift hook attached to after side of conning tower by a rigid, rotatable metal arm. The lift hook is horizontal during a dive and raised to the vertical for launch/retrieval.

External Lighting: Two, 1,000 w, quartz iodide lights mounted on bow.

Life Jackets: Two, inflatable

Surface Lights: One, self-powered, flashing blue light, 70cm (28 in.) above water surface, four to five day duration, one flash/second.

Fire Extinguisher: One, dry chemical

Medical Supplies: First aid kit

Surface Communications: One, VHF, self-powered radio transceiver, range of 15km (8nm).

Sub-Surface Communications: One underwater telephone, 27 kHz, self-powered, CW (Spiro Technique Mfg.).

Sonars: Scanning sonar (Wesmar 120SS). Pinger: One, self-powered, 27 kHz, one ping/second, 30 day duration (Hydro Prod. Mfg.).

Marker Buoy: A stainless steel cylinder with hemispherical end caps, 20cm (7.9 in.) diam., 30cm (11.8 in.) long attached to 250m (820 ft) of 4mm (0.2 in.) diam. nylon line, mechanically released.

Jettisonable Components: One 75kg (166 lbs) weight, mechanically dropped. Positive buoyancy of 502kg (1,109 lbs) can be obtained at operating depth by inflating a balloon held inside a parachute atop the vehicle.

Emergency Breathing: Two, (Drager Mfg.) closed-circuit units provide each occupant the capability of breathing directly through CO₂ scrubber if power fails. One set of scuba tanks, regulator, face mask, flippers and wet suit in LOC.

Egress Procedure: One man can exit through lockout compartment.

Communications Procedure: Check with surface every 15 minutes, dive is not aborted if communications fail.

System Readiness: Operational

Classification/Certification: None

Owner: Skadoc Submersible Systems

Damstraat 104

Yerseke

Netherlands

Operator: Same as above

Builder: Same as above

Point-of-Contact: Richard Pilliard

Smit Lecler

P.O. Box 95

Harvey, LA 70059

Telephone: (504) 368-2803

SNOOPER

CHARACTERISTICS

Length.....	14.5 ft (4.4m)	Hatch Diameter.....	20.5 in. (52cm)
Beam.....	4.1 ft (1.3m)	Life Support Duration.....	72 man hrs
Height.....	7 ft (2.1m)	Total Power.....	9.7 kWh
Draft.....	5 ft (1.5m)	Speed: Cruise (kts/hrs)...	1/5
Weight (dry).....	2.65 tons (2.4t)	Max (kts/hrs).....	2/3
Operating Depth...	1,000 ft (305m)	Crew: Pilot(s).....	1
Collapse Depth...	2,100 ft (640m)	Observer(s).....	1
Launch Date.....	1969	Payload.....	200 lbs (91kg)
		Color.....	White

Pressure Hull: Cylindrical shape, hemispherical end caps, composed of mild (A-212) steel 0.5 in. (1.3cm) thick, 36 in. (91cm) OD on main body and 24 in. (61cm) OD on conning tower. Total length of main pressure hull, 8.3 ft (2.5m); conning tower 2.2 ft (0.7m).

Power Source: Lead acid batteries carried in two, pressure-resistant, droppable pods p/s amidships. Each pod (bank) delivers 200 amp-hrs at 24 V.

Maneuvering Control: One stern-mounted, reversible propeller driven by a three hp electric motor and capable of rotating 110 degrees p/s in the horizontal plane.

Pitch/Trim: A 40 lb (18kg) lead weight is moved fwd/aft on an endless chain by an electric motor to provide a pitch angle of +4 degrees.

Life Support: A total of 40 ft³ (1.1m³) of oxygen is carried in the pressure hull at 1,800 psi (126kg/cm²). CO₂ is removed by scrubbing through baralyme.

Monitor for O₂. Scrubber powered off main battery. O₂ added as indicated by O₂ monitor.

Viewing: Ten viewports, four in conning tower, one in hatch cover, one in stern and four on bow.

Manipulator: One, three degrees-of-freedom with linear extension, non-jettisonable, capable of 30 lb (13.6kg) lift, scissors-type claw.

Lift Point: One, 0.75 in. (1.9cm) thick steel plate is located forward and one aft of the conning tower; each plate has two circular penetrations of 1 7/8 in. (4.6cm) and 0.75 in. (1.9cm) diameter. Any one of these four attachment points can support entire vehicle weight.

Lighting (underwater): A total of six, 250 w each, incandescent lights are mounted under the brow (three port and three starboard).

Life Jackets: Two Stenkie Hoods, inflatable.

Surface Communications: CB transceiver, 5 w, self-powered, hatch must be opened to operate.

Sub-Surface Communications: One underwater telephone operates on 8.0875 kHz and draws power from main batteries (Gen. Oceanographics, Mfg.). Contact established with surface every 30 minutes, but dive is not aborted if unable to establish communications.

Marker Buoys: A yellow, egg-shaped foam float, 1 ft (31cm) long and 7 in. (18cm) wide can be manually released and is held to the vehicle by a 1/8 in. (0.3cm) polypropylene line.

Jettisonable Components: One, 140 lb (63kg) steel weight and two battery pods weighing 600 lbs (272kg) each.

Emergency Breathing: Two scuba regulators draw off MBT air supply. Duration depends upon amount of air in tanks.

Egress Procedure (underwater): Hull can be flooded through a 2 in. (5cm) diam. penetration; occupants may exit wearing Stenkie hoods.

System Readiness: Operational

Classification/Certification: None

Support Ship: M/V MOTHER GOOSE

Owner: Undersea Graphics, Inc.

5436 Sharynne Lane

Torrance, Ca. 90505

Operator: Same as above

Builder: Same as above

Point-of-Contact: Mr. Donald Siverts or Mr. Paul Gamroth
(Address same as above)

Telephone: (213) 379-7271

SUPER SUB I (PC-18)

CHARACTERISTICS

Length.....	24 ft (7.3m)	Hatch Diameter.....	24 in. (61cm)
Beam.....	8 ft (2.4m)	Life Support Duration.....	704 man-hours
Height.....	8.5 ft (2.6m)	Total Power.....	37 kWh
Draft.....	6 ft (1.8m)	Speed: Cruise (kts/hrs)...	NA
Weight (Dry).....	13.5 tons (12.2t)	Max (kts/hrs).....	4/NA
Operating Depth.....	984 ft (300m)	Crew: Pilot(s).....	1
Diver Lockout Depth.....	656 ft (200m)	Observer(s).....	1
Collapse Depth.....	NA	Diver(s).....	2
Launch Date.....	1978	Payload.....	1,000 lbs (453.6kg)
		Color.....	Yellow

Pressure Hull: Cylindrical shape, composed of low temperature steel, 54 in. (137cm) ID, diver lockout compartment.

Power Source: Two separate power sources comprised of 12 VDC heavy duty lead acid storage batteries in pressure-resistant droppable pods to provide 120 VDC main power and 24 VDC instrument power. Total storage capacity is approximately 37 KWH at 20-hour discharge rate (21 KWH at 120 VDC and 6 kWh at 24 VDC). A surface power pack provides surface power through a tether umbilical to the submersible. In this mode of operation vehicle endurance is not restricted by vehicle on board battery capacity. The system design permits field change over from normal dual battery pod free flying operation mode to the surface powered tethered operation mode in about 2 hours. The change over procedure involved generally only the replacement of the slide out battery trays in the port pod with slide in AC transformer trays. In the tethered mode of operation the umbilical cable may be used to pull the submarine to the surface in an emergency. Umbilical breaking strength is in excess of 5,000 lbs (2,268kg). In the event of entanglement the umbilical the submersible may free-fly and surface using the on board battery capacity in the starboard battery pod.

Maneuvering Control: Main propulsion is provided by a 10 hp (7.5 kw) DC electric motor with electronic variable speed control. The motor and shaft seal assembly are contained in a separate pressure vessel that pivots plus or minus 90 degrees either side of center to provide steerage. Hovering and low speed maneuverability are supplemented by two electric thrusters which each deliver approximately 70 lbs (32kg) of static thrust and are reversible.

Trim/Pitch Control: A variable buoyancy/trim system of 700 lbs (318kg) with forward and aft tanks is provided. One tank with a capacity of 200 lbs (91kg) is located in the pilot's compartment and one tank with a 500 lb (225kg) capacity is located in the lockout compartment. A high pressure pump provides overboard discharge and transferring water between tanks.

Life Support: Oxygen flasks carried externally, 6,000 SCF (170 SCM) of gas storage available for diver support. Monitors: O₂ (primary and backup), CO₂ (primary and backup), altimeter.

Viewing: Hemispherical bow dome, 35 in. (89cm) diameter. Eight equally spaced 8 in. (20cm) major diameter viewports girdle the conning tower. Similar sized viewports are in the conning tower hatch cover (1 each) and the internal and external DLO hatch covers. External color TV camera is mounted on a pan/tilt mechanism.

Manipulator: Two Perry manufactured manipulators capable of six degrees-of-freedom, and 150 lbs (68kg) lift at full extension. Parallel jaws type claw with 4 in. (10cm) maximum opening.

Lift Point: Single point lift with multiple attachment points for variation in trim.

External Lighting: Two lights forward and one for illumination of DLO exit trunk area. All are 500 watt, quartz-iodide with high-intensity reflectors.

Life Jackets: Four, inflatable

Surface Light: Flashing, self-powered strobe light mounted on conning tower.

Surface Communications: Twenty-three channel, 5 watt 27. MHZ business/CB radio telephone equipped with microphone and speaker. The surface station comprised of an identical unit with antenna installation kit.

Sub-Surface Communications: A two station dual frequency, 20/100 watt underwater telephone system. The submarine station consists of the submarine transceiver, four surface and bottom directed transducers, and the electrical hull penetration cable assembly. The surface station is comprised of a transceiver, two transducers, and a 50 ft (15m) transducer cable assembly. A hardwire system is included which uses the umbilical cable when attached.

Sonars: Echo sounder. Wesmar SS14CS Scanning Sonar.

Jettisonable Components: Battery pods.

Emergency Breathing: Mouthpieces are provided which draw off the high pressure air system.

Egress Procedure: Through DLO compartment.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: NA

Owner: Superpesa Transportes de Maritimos Ltd.
Rio de Janerio, Brazil

Operator: Same as above

Builder: Perry Oceanographics, Inc.
Riviera Beach, Fl.

Point-of-Contact: Superpesa Transportes de Maritimos Ltd.
Rua Araiyo Porto Alegre, 36-1209
Rio de Janerio - 20.000 - Brazil
Telephone: 222-5110
Telex: 2121499

T-1

CHARACTERISTICS

Length.....	21 ft (6.4m)	Hatch Diameter.....	19 in. (48.3cm)
Beam.....	10.8 ft (3.3m)	Life Support Duration.....	19 man days
Height.....	11 ft (3.4m)	Total Power.....	68 kwh
Draft.....	8 ft (2.4m)	Speed: Cruise (kts/hrs)...	2kts/5hrs
Weight (dry).....	30,200 lbs (13.7t)	Max (kts/hrs).....	2kts/5hrs
Operating Depth.....	3000 ft (914m)	Crew: Pilot(s).....	1
Collapse Depth.....	6000 ft (1829m)	Observer(s).....	1
Launch Date.....	1976	Payload.....	2000 lbs (907.2kg)
		Color.....	White

Pressure Hull: Spherical shape composed of HY100 steel, 80 in. (203cm) diameter, 1 in. (2.5cm) thick.

Power Source: Lead acid batteries in pressure-resistant pods provide 120VDC at 500 amp-hrs and 24VDC at 360 amp-hrs. Emergency power is supplied by a 24VDC, 20 amp-hr battery.

Maneuvering Control: Dynamic: three, 5 hp (each) thrusters, one each port and starboard and one on the bow. Static: one hard tank of 1000 lbs (453kg) capacity and three soft tanks of 2200 lbs (998kg) total capacity.

Trim/Pitch Control: Movable lead weight 700 to 1000 lbs (318 to 453kg) hydraulically driven can provide 10 degree down and 20 degree up angle on the bow.

Life Support: Oxygen carried externally at 3000 psi (211kg/cm²) pressure and 384SCF (11m³) capacity. CO₂ is removed by scrubbing through soda sorb (routine) and lithium hydroxide (emergency). O₂, CO₂, temperature, humidity and cabin pressure are monitored every 15 minutes.

Viewing: Three, 8 in. (20cm) viewports looking forward. Two trainable CCTV cameras on bow, one periscope TV camera.

Manipulators: Two, one grasping and one working. Grasping manipulator: 24 in. (61cm) extension, hydraulically-powered, three degrees-of-freedom, "C" shaped claws when opened, 200 lbs (91kg) lift capacity, claws jettisonable. Work manipulator: 84 in. (213cm) extension, hydraulically-powered, six degrees-of-freedom, parallel jaws type claw, 120 lb (54kg) lift capacity, claws jettisonable.

Lift Points: Normal lift point is a Rams Horn-shaped HY-100 steel plate with a 2.5 in (6.4cm) diameter, circular hole penetration. Two 5 in. (12.7cm) diameter lift rings are located port and starboard which have a wire rope connected from them to the Rams Horn for emergency retrieval.

External Lighting: Four units total, three are fixed and one is trainable. Three are 1000 watts, one is 500 watts; the former is quartz iodide and the latter is thallium iodide.

Life Jackets: Two, inflatable.

Surface Light: One, flashing white, self-powered, one flash every three seconds.

Fire Extinguisher: Two, Halon 1301.

Emergency Food and Water: Fourteen man-days duration. Dehydrated food, 14-21 oz. cans of water. Two exposure suits.

Medical Supplies: First aid kit.

Surface Communications: VHF (Storno COM6R), 5.6km (3nm) range, 10 watts, 157.65, 156.80, 156.65 MHz frequencies, emergency battery supplied.

Sonars: Scanning sonar (Wesmar SS140S), 160kHz, 360 degrees trainable in the horizontal. Pinger, two each, 10 or 27 kHz, one pulse/second. Transponder (AMF Mfg.), 11 kHz.

Marker Buoy: One releaseable 10 in. (25.4cm) diameter sphere attached to a 3000 ft (914m) line.

Sub-Surface Communications: One underwater telephone (Subcom Mfg. Mod. 200S-20), 10 and 27 kHz. Two transducers topside and two on keel. Can operate off emergency power supply.

Jettisonable Components: Trim weight-700 to 1000 lbs (317-453kg), battery pods - 1100 lbs (499kg) each, thrusters - 180 lbs (82kg) each, manipulator claw - 50 lbs (23kg), manipulators - 40 lbs (18kg). Total weight - 3650 lbs (1655kg). All components are jettisoned by hydraulically-operated mechanical releases.

Emergency Breathing: Two Draeger self-contained breathing devices, 30 minutes duration each.

Communications Procedure: Surface check every 15 minutes, abort dive after 45 minutes if no communications have been established.

System Readiness: Operational

Classification/Certification: Lloyds Register of Shipping

Support Ship: Any of the following: VICKERS VOYAGER, VICKERS VIKING, VICKERS VANGUARD, VICKERS VISCOUNT, F.O.O. BORGHOLM.

Owner: Vickers Oceanics Ltd.

Leith, Edinburgh
Scotland

Operator: Same as above

Builder: Vickers Slingsby

Kirbymoorside, Yorkshire

Point-of-Contact: Vickers Oceanics Ltd.

P.O. Box 215
Leith, Edinburgh
Scotland
Telephone: 031-554-4411
Telex: 72248

TAURUS A

CHARACTERISTICS

	35.5 x 38 in. (90 x 96.5cm) DTC
Length.....	33.3 ft (10.1m)
Beam.....	10.7 ft (3.3m)
Height.....	10.7 ft (3.3m)
Draft.....	NA
Weight (dry).....	26.5 tons (24t)
Operating Depth.....	1,100 ft (335m)
Collapse Depth.....	NA
Launch Date.....	1977
Hatch Diameter.....	27 in. (69cm) Pilots'
Life Support Duration.....	1,008 man hrs
Total Power.....	126 kWh
Speed: Cruise (kts/hrs)...	NA
Max (kts/hrs).....	3/NA
Crew: Pilot(s).....	1
Observer(s).....	1
Diving Supervisor..	1
Divers.....	3
Payload.....	3,300 lbs (1,477kg)
Color.....	White and Orange conning tower

Pressure Hull: Two sections composed of A516 Grade 70 steel. Forward (command or pilot's) section is cylindrical with hemispherical end caps, 72 in. (183cm) diam., 80 in. (203cm) total length. The after Dry Transfer Chamber (DTC) is bolted to the command section, it is a sphere 84 in. (213.4cm) in diameter. A 27 in. (68.6cm) opening is between both sections and can be sealed by a hatch when the DTC is pressurized.

Power Source: Lead acid batteries, pressure compensated providing 120V at 1,000 amp-hrs (eight hr rate) and 24 V and 12 V at 300 amp-hrs. A 20 amp-hr (eight hr rate) 12 V gel cell is carried inside the pressure hull for emergency power.

Maneuvering Control: Four thrusters, all five hp with Kort nozzles. Two are mounted p/s at the center of gravity, these are trainable in the vertical plane from 90 degrees up to 90 degrees down. Two are mounted on the stern and one trainable 90 degrees p/s to provide main and lateral propulsion.

Pitch/Trim: A 1,000 lb (452kg) lead weight can be moved forward or aft to provide ± 12 degree bow angle. Two "hard" tanks forward and one aft are for transfer of water to obtain maximum bow angles of ± 25 degrees. Total volume capacity of these tanks is 2,800 lbs (1,266kg).

Life Support: O₂ carried externally. CO₂ removed by LiOH and/or soda sorb. Monitors for O₂, CO₂, temperature, pressure, humidity.

Viewing: Acrylic plastic bow dome 36 in. (91cm) ID. Five, 5 in. (12.7cm) ID viewports girdle the conning tower; one 6 in. (15.2cm) ID viewport in the DTC hatch covers. External TV camera and video recorder.

Manipulators: Two, one heavy duty and one articulated.

Lift Point: One metal padeye located immediately aft of conning tower fairing with a circular opening.

External Lighting: Three, 1,000 w, incandescent for viewing. Two, 250 w, mercury vapor lights for TV.

Emergency Food and Water: Food and water equal to life support. Exposure suits.

Medical Supplies: First aid kit.

Surface Communications: VHF FM transceiver.

Sub-Surface Communications: Underwater telephone.

Sonars: Scanning sonar (Wesmar SS140S), 160 kHz, 1,600 ft (488m) range, trainable +four degrees to -90 degrees from the horizontal, 360 degree lateral coverage.

Echo sounder, Doppler sonar, directional antennae.

Marker Buoy: One.

Jettisonable Components: A 1,000 lb (452kg) lead weight is mechanically droppable. Thrusters and manipulator claws are also jettisonable.
Emergency Breathing: Closed-circuit units for each occupant.

System Readiness: Vehicle is presently at Vickers Oceanics Ltd., Scotland where it is under charter.

Classification/Certification: ABS

Support Ship: VICKERS VOYAGER

Owner: Hyco Subsea Ltd.

P.O. Box 1059

Station "A"

Vancouver, B.C. V6C 2P1

Canada

Operator: Same as above

Builder: International Hydrodynamics, Ltd.

No. Vancouver, B.C.

Canada

Point-of-Contact: Michael D. Macdonald

(Address same as owner)

Telephone: (604) 681-0346

(604) 688-8607

Telex: 04-55465

TRIESTE II

CHARACTERISTICS

Length.....	78 ft 6 5/8 in. (23.9m)	Hatch Diameter.....	16.9 in. (42.9cm)
	86 ft 3 5/8 in. (26.5m)	Life Support Duration....	139.5 man hrs
	(with bow - frame)	Total Power.....	NA
	15 ft 3 1/4 in. (4.7m)	Speed: Cruise (kts/hrs).	1.5/11.9
	(hull only)	Max (kts/hrs.....	NA
Beam.....	18.75 ft (5.7m) (between	Crew: Operator(s).....	2
	motors)	Observer(s).....	1
Height.....	26 ft 11 in. (8.2m)	Payload.....	NA
Draft.....	10 ft 8 in. (3.3m)	Color.....	White
	(without gas & shot)		
	18 ft 8 in. (5.7m)		
	(with gas & shot)		
Weight.....	300 tons (276t) (with-		
	out gas & shot)		
Operating Depth...	20,000 ft (6,096m)		
Collapse Depth....	31,793 ft (9,691m)		
Launch Date.....	1969		
	New sphere 1969		

Pressure Hull: Spherical shape composed of HY 120 steel, 7 ft (2.1m) ID, 4 in. (10.1cm) nominal thickness.

Power Source: Silver Zinc batteries, pressure compensated, providing 120 VDC at 952 amp-hrs (propulsion) and 24 VDC at 5,000 amp-hrs (auxiliary). Emergency power provided by a silver zinc battery inside the pressure hull, 24 VDC at 200 amp-hrs, operates ballast control, communications, propulsion control, alarm panel, CO₂ scrubbers, pressure/depth systems, echo sounder, ante-chamber blow system, battery monitor alarm, internal lights, emergency/tracking pinger, atmospheric monitors.

Maneuvering Control: Main propulsion is provided by three, 6.5 hp (ea.) stern-mounted, reversible propellers (with kort nozzles). A 6.5 hp, reversible bow thruster assists in lateral maneuvering.

Life Support: O₂ carried inside hull in three flasks (two for routine; one for emergency), the volume of each flask is 730 in.³ (11,965cm³) and each is charged to 2,250 psi (158kg/cm²). CO₂ is removed by scrubbing with LiOH. O₂, CO₂, temperature, humidity and pressure are monitored continuously and recorded every 30 minutes. O₂ and CO₂ monitors are connected to an aural (buzzer) and visual (red light) alarm. There are three O₂ monitors and two CO₂ monitors.

Viewing: One major viewport looks forward and down. Two smaller viewports, one looks directly aft and one is in the hatch cover. Three external TVs, all on pan and tilt mechanisms, one video recorder. Provisions are available for a fourth camera.

Manipulators: One, hydraulically-powered, six degrees-of-freedom with wrist rotate, parallel jaws type claw, jettisonable.

Lift Point: Not feasible to consider as an underwater retrieval factor.

External Lighting: Eight gas discharge lights, five are thallium iodide, 400 watts each; three are multivapor at 400 watts each. Ten quartz iodide, eight are 300 watts and two are 500 watts. Two 500 watts incandescent.

Life Jackets: Three, inflatable.

Radar Reflector: One, permanently-mounted, 12 ft (3.7m) above water level, corner reflector, solid.

Surface Lights: Two, flashing white, 7 ft (2.1m) above water line, 300 watt-seconds each, pressure-activated, one flash every three seconds.

Fire Extinguisher: One, carbon dioxide.

Emergency Food & Water: Water from atmospheric cooler/dehumidifier is potable.

Automatic Deballasting: Twenty eight tons (25t) of shot, manipulator, trail ball will automatically be jettisoned 33 hours after submerging.

Surface Communications: One radio transceiver, VHF (143.7 MHz), 5 watts. Optional mode provides homing beacon (tone modulated at 800 Hz).

Sub-Surface Communications: One, underwater telephone, 8.0875 kHz, 400 watts, single side band, CW.

Surface Homing Devices: The radio transceiver includes a beacon option.

Sonars: One CTFM scanning sonars (Ametek Straza Mod. 500) modified to provide two external systems with one internal display, 87 to 72 kHz, 360 degree pan (manual control). One pinger (Sperry Mfg.), 32 kHz tracking frequency, 37 kHz emergency frequency, tracking: one ping/sec continuous, emergency: one ping/sec/eight seconds; 24 seconds silence, 96 hrs duration. Transponder (Sperry Mfg.), receives on 7 kHz responds on 12.5, 13 and 17.5 kHz (selectable). Echo sounder looks downward, strip chart recorder, 50 kHz, 2,400 ft (731m) range. Doppler sonar navigator. Transponder interrogator (control in sphere), transmits on 7 kHz; receives on 10 channels 12.5 kHz through 17 kHz incrementally.

Jettisonable Components: Shot, manipulator, trail rope winch, shot pans. Scientific packages (two each) can also be jettisoned when carried.

Emergency Breathing: Three full facemasks, closed-circuit, draws off emergency oxygen and exhales through two LiOH cannisters (60 man-hrs each scrubbing capacity). System is manpowered, 120 man-hrs breathing duration.

Communications Procedure: Surface communications checked every 30 minutes; if no contact is established the dive is aborted.

System Readiness: Operational

Classification/Certification: U.S. Navy certified

Support Ship: USS Pt. LOMA (AGDS-2)

Owner: U.S. Navy

Operator: Submarine Development Group One
San Diego, CA

Builder: Mare Island Naval Shipyard

Point-of-Contact: Commander
Submarine Development Group One
San Diego, CA
Telephone: (714) 225-6583

URF

CHARACTERISTICS

Length.....	13.5m (44.3 ft)	Hatch Diameter.....	600mm (24 in.)
Beam.....	4.3m (14.1 ft)	Life Support Duration.....	980 man hrs
Height.....	4.1m (13.4 ft)	Total Power.....	22 kW
Draft.....	2.9m (9.5 ft)	Speed: Cruise (kts/hrs)...	2/10
Weight (dry)....	50t (55 tons)	Max (kts/hrs).....	3/5
Operating Depth..	460m (1,509 ft)	Crew: Pilot(s).....	5 (Pilots 2, Engineer 1, Divers 2)
Collapse Depth...	900m (2,952 ft)	Rescuees.....	25
Launch Date.....	Spring 1978	Payload.....	2.2t (2 tons)
	(under construction)	Color.....	White with international orange sail and rudder/ dive planes

Pressure Hull: Four compartments: 1) a cylindrical compartment for machinery, 2.0m (6.6 ft) ID and 2.8m (9.2 ft) long; 2) a spherical pilot's compartment 1.73m (5.7 ft) ID; 3) a spherical and cylindrical rescue compartment with 2.8m (9.2 ft) and 2.0m (6.6 ft) ID respectively located between the pilot's sphere and the cylinder for machinery, the cylindrical part 2.8m long and 4) a spherical diver's compartment 2.0m (6.6 ft) ID located aft. The three spherical parts are composed of mild steel, the cylindrical parts of HY-130 steel.

Power Source: A total of 64, 2.3 V lead acid batteries rated at 1,500 amp-hrs are located within a pressure-compensated container beneath the rescue cylinder.

Maneuvering Control: Static: Four MBTs of 0.8m³ (28 ft³) each and one VBT of 0.7m³ (25 ft³) capacity. Dynamic: Two main thrusters mounted p/s forward over the rescue skirt are fixed, reversible, six hp and fitted with a kort nozzle. Two, six hp, horizontal and two vertical thrusters are located forward and aft and ducted within the fairing.

Pitch/Trim: Bow angles of ± 30 degrees may be obtained by transferring 24.9 l (6.6 gal) of mercury forward or aft. Roll angles of ± 45 degrees can be obtained by readjusting two externally placed 750 kg (1,650 lbs) each, arm-mounted weights to different positions.

Life Support: A total of 26 50 l (13 gal) capacity each, flasks are located external to the hull, three carry O₂; five carry H₂; and 16 carry H₂O₂ and two carry air all at 200 bars (2,900 psi) pressure. CO₂ is removed by scrubbing with soda lime. Monitors for O₂ are supplied in diver's compartment and silica gel is distributed to control humidity. Life support by compartment: Pilot's sphere - 168 man hrs; Machinery sphere - 84 man hrs; Diver's sphere - 178 man hrs; Rescue cylinder - 550 man hrs.

Viewing: Eleven viewports total. Three in conning tower (small diam.). Three 490 mm (19.3 in.) ID in pilot's sphere. The remaining five are 170 mm (6.7 in.) ID and are located as follows: one in hatch cover of mating skirt, one in lower diver's sphere hatch cover, and one in each door between compartments. A television camera is situated to view the area within and below the mating skirt.

Manipulator: One, jettisonable, with three degrees-of-freedom and linear extension. This is not a multi-purpose manipulator, it is only used to attach a down-haul line to the stricken vehicle's hatch cover in order to mate.

Lift Points: Two, steel, circular, 65 mm (2.6 in.) ID, 92 mm (3.6 in.) thick, located forward and aft. The forward point can sustain 35t (38.5 tons), the after point 23t (25.3 tons).

External Lighting: Eight lights, quartz iodide, 250 and 1,000 w all mounted forward/down and beside the diver's exit hatch.

Surface Lights: One, white, non-flashing mounted on the rudder some 800 mm (31.5 in.) above the water surface and is powered from the main batteries.

Fire Extinguisher: One in pilot's sphere, dry chemical; three in auxiliary compartment, dry chemical.

Emergency Food & Water: The following quantities of fresh water are carried: 8 l (8.5 qts) in pilot's sphere; 45 l (48 qts) in rescue cylinder; 4 l (4.2 qts) in auxiliary compartment; 8 l (8.5 qts) in diver's sphere.

Surface Communications: One VHF transceiver, powered off the main batteries, 100-156 MHz, 5-6nm (9-11 km) range. Can be used as surface emergency beacon.

Sub-Surface Communications: One underwater telephone, with two transducers (one upward; one aft), 8.0875 kHz, CW, 100 w, operates off main batteries. Diver-to-sub communications is by hardwire. Powered intercom throughout sub and sound-powered system for backup.

Surface Homing Devices: One, frequency of 100-156 MHz.

Sonars: Scanning sonar (Straza CTEM Mod. 500), 87-72 kHz, can also serve as directional antennae from 36.5 to 37.5 kHz. Pingers: One, 37 kHz, self-powered, 30 days duration, one second rep. rate, pilot-activated.

Jettisonable Components: Two tons (2t) of iron shot, roll adjustment weights, manipulator and main thrusters. MBTs and VBT can be blown or pumped (VBT only) at operational depth.

Emergency Breathing: Systems in the diver's and auxiliary compartment draw off main ballasting air, approximately 36 man hrs duration. If main power lost in CO₂ scrubber, individual systems can be donned that manually draw air through the scrubbing system.

System Readiness: Under construction, ready by Spring 1978.

Classification/Certification: Built to Royal Swedish Navy standards.

Owner: Royal Swedish Navy

Operator: Same as owner

Builder: Kockums Shipyard

Fack, S-20110

Malmo 1

Sweden

Point-of-Contact: Capt. Johan Onnermark

Storovagen 13

13200 Saltsjo-boo

Stockholm

Sweden

L1 (VOL LI)

CHARACTERISTICS

Length.....	33.3 ft (10.1m)	Pilot's comp (hatch diam)....	23 in (58cm)
Beam.....	10.8 ft (3.3m)	Hatch Diameter.....	LOC 28 in. (71cm)
Height.....	10.8 ft (3.3m)	Life Support Duration.....	35 man days
Draft.....	5.3 ft (1.6m)	Total Power.....	46.7 kWh
Weight (dry).....	16 tons (14.5t)	Speed: Cruise (kts/hrs)...	2/NA
Operating Depth.....	1200 ft (366m)	Max (kts/hrs).....	3.4/NA
Collapse Depth.....	1800 ft (549m)	Crew: Pilot(s).....	1
Launch Date.....	1973	Observer(s).....	4
		Payload.....	600 lbs (272 kg)
		Color.....	White

Pressure Hull: Two cylinders joined to form a forward (pilot's) compartment and an after LOC. Both sections are composed of A537GRA steel, the pilot's compartment is 4.5 ft (1.4m) OD and 8.8 ft (2.7m) long, the LOC is 4.5 ft (1.4m) OD and 6.6 ft (2.0m) long. Access from one compartment to the other is a 2 ft (0.6m) diameter hatch.

Power Source: Lead acid batteries in two pressure-resistant pods, batteries are arranged to provide four banks of 24V and 120V, each four-bank system totals 324 amp-hr.

Maneuvering Control: Main propulsion is from a fixed, stern-mounted, screwtype propeller powered by a ten hp motor. Lateral movement is provided by two thrusters, one mounted forward and one aft. Vertical movement is provided by two aft vertical thrusters. Dive planes assist in dynamic pitch control.

Pitch/Trim: Internal tanks forward and aft can be differentially filled to obtain up/down angles.

Life Support: O₂ is carried in three external flasks each holding 332 ft³ (9.4m³) at 3000 psi (211kg/cm²). CO₂ is removed by scrubbing through LiOH in the pilot's compartment and through soda sorb in the LOC. Pilot's compartment contains monitors for O₂, CO₂, temperature, humidity and pressure; these are monitored continuously. LOC carries monitors for O₂, temperature and pressure.

Viewing: Six viewports girdle the conning tower and one is in the hatch cover. LOC has viewports in the lockout hatch covers. A 34 in. (86cm) diameter acrylic plastic dome is in the bow. Two television systems, one is forward on pan and tilt mechanism; the second uses a camera in the LOC which can be carried out by the divers or an extra camera carried in the pannier.

Manipulator: One, five degrees-of-freedom, lift capacity of 200 lbs (90.7kg) at maximum extension, scissors and parallel jaws-type claws.

Lift Points: There are two points (pilot's compartment, LOC) where a standard shackle can be attached to provide 16 tons (14.5t) lift.

External Lighting: Seven units total, five mounted forward and one mounted aft on the LOC. All are quartz iodide and 500w each.

Life Jackets: Five inflatable.

Surface Light: One flashing light, blue/white, 1 ft (0.3m) above water surface, self powered.

Fire Extinguisher: Two, dry chemical.

Emergency Food and Water: Seven gallons (27 l.) of water are carried and food blocks to provide 35 man-days duration.

Medical Supplies: First aid kit.

Surface Communications: VHF transceiver (Storno CQM6R), ten w marine band, line of sight range, three channels (156.55, 156.80, 157.65 MHz), main and emergency power.

Sub-Surface Communications: One (Subcom Sys. Mfg.) 10 or 27 kHz, transducers mounted atop vehicle, operates off main or emergency power supply.

Sonars: Scanning Sonar (Wesmar SS130) 360 degree scan, 160 kHz. pinger mode built into underwater telephone (subcom Sys. Mfg.) 10 or 27 kHz, one pulse/second rep. rate, two transducers. Directional Antennae (Helle Mfg.) receives from 27 kHz. Transponder carried (AMF or VOL Mfg.), frequency and characteristics vary according to task.

Marker Buoy: One, spherical shape, 10 in. (25.4cm) diameter, hydraulically released and attached to 2000 ft (610m) of line.

Jettisonable Components: Manipulator and battery pods can be jettisoned by activating an emergency hand pump. Total weight: 6909 lbs (3134kg).

Emergency Breathing: Five regulators are available for emergency breathing which draw off the MBT air supply

Communications Procedure: Check with surface every 15 minutes; abort dive if communications are not established within 30 minutes.

System Readiness: Operational

Classification/Certification: ABS

Support Ship: VICKERS VIKING

Owner: Vickers Oceanics Ltd.

P.O. Box 215

Leith, Edinburgh,

Scotland

Operator: Vickers Oceanics Ltd.

P. O. Box 2.5

Leith Docks

Edinburgh, Scotland

Builder: Perry Submarine Builders Inc.

Riviera Beach, Florida

Point-of-Contact: Base Duty Officer

(address same as operator)

Telephone: 031 554 4411

Telex: 72248

WASP

CHARACTERISTICS

Length.....2.1m (6.9 ft)	Hatch Diameter.....NA
Beam.....NA	Life Support Duration.....54 man hours
Height.....NA	Total Power.....Indefinite
Weight (Dry).....500kg (1,102 lbs)	Speed: Max (kts/hrs).....1.5/indefinite
Operating Depth.....610m (2,000 ft)	Cruise (kts/hrs)...NA
Collapse Depth.....NA	Crew: Pilot(s).....1
Launch Date.....1977	Observer(s).....0
	Payload.....NA
	Color.....Yellow (upper half)
	Black (lower half)

Pressure Hull: Cylindrical shape. Main body constructed of aluminum casting. Trunk is a filament-wound, resin-impregnated tube. Bow or top is a hemispherical macrilon protective dome, over a glass pressure hull.

Power Source: All power is provided through a surface-connected umbilical cable. Batteries are carried in a pressure-resistant chamber and provide 40 minutes of power at full thrust.

Maneuvering Control: Two thrusters are mounted port and starboard amidships. Each thruster can rotate 360 degrees in the vertical plane and each is reversible. Control of the thrusters is by the operator's feet. Vehicle's trim can be altered by varying the buoyancy through foot-operated pumps.

Life Support: A built-in, fully-automatic system provides 8-hours endurance. An oral-nasal face mask can provide 36-54 hours.

Viewing: Glass bow dome provides 360 degrees of vision.

Manipulator: Two articulated arms into which the operator places his arms. Arms will follow motion of the operator. A variety of interchangeable claws are available.

Surface Communications: Hardwire communications through umbilical (2 lines).

Sub-Surface Communications: Hardwire communications through umbilical. An acoustic communication system is provided in the event of hardwire failure.

Sonars: A self-powered, pressure-activated pinger is carried for location if power fails.

Jettisonable Components: Umbilical cable. Thruster and all external equipment can be released to provide 46kg (150 lbs) of positive buoyancy.

Emergency Breathing: An oral-nasal mask provides 36-54 hours.

System Readiness: Operational (2 vehicles)

Classification/Certification: Lloyds Register of Shipping

Support Ship: Ship of Opportunity.

Owner: Oceaneering International
Santa Barbara, Ca.

Operator: Same as Owner

Builder: Offshore Submersibles, Ltd.
Great Yarmouth, Norfolk
England

Point-of-Contact: Mr. Graham Hawkes
OSEL Group
Boundary Road
Harfreys Industrial Estate
Grand Yarmouth, Norfolk
England
Telephone: 0493 55671
Telex: 975084 OSEL G

4.0 SEARCH/RETRIEVAL ASSETS

Search/retrieval assets are herein defined as those devices which can be employed to either locate the submersible underwater, or provide the rescuers a capability to assess the submersible's condition and the nature of its entrapment. This assessment capability may be provided by photography (cine or still camera), by television or by visual observations from divers. In some instances the search asset may also provide the capability for attaching a retrieving line.

It is difficult to define the limits or boundaries of this category. For example, the Naval Ordnance Laboratory (NOL) device that was used in retrieval of JOHNSON-SEA-LINK in 1973 was an "eleventh hour" approach which proved successful. Prior to this incident, the NOL device, which was designed for the specific purpose of hardware inspection in the Gulf Stream, was not considered a submersible search/retrieval asset in any public Naval document; it is still not included in a recent Navy Laboratory inventory of search/retrieval assets that post-dates the JOHNSON-SEA-LINK tragedy. Likewise, there are innumerable other devices and capabilities which, at the last moment, may serve as the means of retrieval. Therefore, a practical limit must be placed somewhere in order to avoid listing every grapnel hook, diver, dredge, and underwater camera and television unit in the world. The limit, therefore, was arbitrarily drawn at: 1) a minimum 600 ft (183m) depth capability; 2) a real-time viewing capability offered through television or the human eye and 3) a means to control and maneuver the television platform in the x, y and z axis. The towed devices are included in this category because they offer multi-instrumented search capabilities with long-duration and relatively high speed.

Availability

There is only one known search/retrieval asset that is maintained in a ready-to-go condition at all times: the U.S. Navy's DEEP DRONE. When not undergoing training or evaluation dives, DEEP DRONE is maintained and operated by a full-time crew that can be mobilized on call. This unit is located at Camp Springs, Maryland.

Commercial search/retrieval assets are not purchased and maintained to stand by and wait for an emergency application. They are assets which were built to be used as frequently as possible for a variety of tasks. Their capability as a submersible rescuer is incidental to their capability as an underwater work platform. To economically justify their existence, they must be employed, and this employment can be anywhere at any particular time. Consequently, it is impractical to state that vehicle "x" can be mobilized in a certain amount of hours or days and will require a specific amount of time to be shipped from its home port to the emergency site. The only way a meaningful emergency response time can be derived is to maintain a weekly, or even daily, check on a particular vehicle's status and location. For these reasons, availability data is not included in the following discussions other than to note, under "Remarks", that the device or capability is under design or under construction. All other assets can be assumed operational unless otherwise stated.

4.1 Remotely Operated Vehicles (ROV's)

Remotely Operated Vehicles are linked to a surface platform by a cable. The cable, in most instances, supplies electrical power to the vehicle's propulsion system and instruments. In all instances it serves to carry control commands to the electrical components and to transfer data from the device to the surface. For simplicity, ROV's are categorized herein as: 1) Towed systems and 2) Self-propelled, tethered systems; these are defined and discussed in the following sections.

4.1.1 Towed Systems

Towed systems include all systems that rely upon a moving surface platform for propulsion. They are employed by being towed at some near-constant height (altitude) off the bottom. Power for these systems is generally supplied from the surface platform. Maneuverability is provided by the surface platform and a winch operator; hence, they are limited to three motions: thrust (forward motion) and heave (up/down motion). Yaw is obtained by maneuvering the towing vessel.

Excluded from this category are towed systems which are dragged along the bottom. From a search/retrieval aspect, such systems, owing to their lack of maneuverability, may further compound an entanglement situation by becoming fouled themselves.

Nine towed systems have been identified worldwide which can be considered as potential candidates for submersible search/identification missions. These are listed in Table 4.1. Only two of these devices, DSS-125 and SEA PROBE, are owned by private industry. The remainder are owned by the U.S. Navy (DEEP TOW, NRL System, TELEPROBE) and academic/research activities (BATFISH, CRAB, RUFAS II, S³).

All of the towed systems listed have closed circuit television and, except for CRAB and DSS-125, some form of scanning sonar to provide a relatively long range acoustic search capability. The potential effectiveness of these systems, particularly those with depth capabilities exceeding 10,000 feet (3,048m), in locating a stricken submersible in time to affect rescue is speculative. While mobilization time (that period required to load the system components on a truck) may be 24 or 48 hours with maximum effort, there are other factors which govern at-sea employment. The major factor is that of locating a surface ship that has a winch suitable to accommodate the power/lift cable and a system for handling the device over-the-side. Ships of the U.S. Navy AGS and AGOR-types are suitable, but they do not remain on standby awaiting the call for rescue. Furthermore, they may be operating in areas far distant from the scene of the emergency. In Section 5.6.1 the average submersible life support duration was calculated at 90 hours or 3.75 days per occupant. Under the best conditions, 24 hours would be required to merely mobilize the deeper towed systems, leaving the occupants 2.5 days of life support. Considering that the AGS and AGOR-type ships can make approximately 13 knots (24km/hr) top speed, at least 24 hours must be allowed to reach a suitable

TABLE 4.1 TOWED SYSTEMS

<u>NAME</u>	<u>OWNER</u>	<u>OPERATING DEPTH (ft/m)</u>	<u>DRY WEIGHT (lbs/kg)</u>	<u>MAX. SPEED (kts/km/hr)</u>	<u>POWER REQUIREMENTS</u>	<u>WORK EQUIPMENT</u>	<u>REMARKS</u>
BATFISH	Bedford Inst. of Oceanology, Halifax, NS	650 198	156 71	5 9	110 VAC, 6 Hz	TV, still camera side scan sonar	Operational
CRAB	Inst. of Oceanology Moscow	13,123 4,000	1,548 702	NA	Lead acid	TV, manipulator	Employed by drifting; can be placed on bottom to sample or observe.
DEEP TOW	Marine Physics Lab. San Diego, CA	20,000 6,096	2,000 907	1.5 2.8	NA	TV, still camera magnetometer, side scan sonar, sub-bottom profiler, echo sounder, diff. pressure gauge	Operational
DSS-125	Hydro Products San Diego, CA	20,000 6,096	5,100 2,313	1.5 2.8	115 VAC, 60 Hz, 20 amps, or 220 VAC, 50 Hz, 10 amps	TV, still camera	
NRL System	Naval Research Lab. Washington, D.C.	20,000 6,096	2,200 998	3 1.6	20 amp-hr, nickel cad batteries, 28 VDC	TV, still cameras, magnetometer, side scan sonar, water sampler, sub-bottom profiler.	No dedicated support ship; would require least 48 hrs to mobilize.
RUFAS II	National Marine Fisheries Services Bay St. Louis, MS	2,400 731	1,000 453	6 11.1	115 VAC, 12 VDC 4 kw total	TV, still camera, scanning sonar	Undergoing tests; planned operational by mid-1979.

TABLE 4.1 TOWED SYSTEMS (Cont.)

<u>NAME</u>	<u>OWNER</u>	<u>OPERATING DEPTH (ft/m)</u>	<u>DRY WEIGHT (lbs/kg)</u>	<u>MAX. SPEED (kts/km/hr)</u>	<u>POWER REQUIREMENTS</u>	<u>WORK EQUIPMENT</u>	<u>REMARKS</u>
S ³	Univ. of Georgia Athens, Ga.	6,000 1,829	700 317	1 1.8	NA	TV, side scan sonar, magnetometer, sub-bottom profiler, dredge	Has terrain following guidance system. Requires 30 days to become operational.
SEA PROBE*	Alcoa Marine Corp. Washington, D.C.	10,000 3,048	---	0.5 0.9	NA	TV (2 ea), still camera (35mm), side scan sonar	Two weeks to mobilize. Can lift 200 tons (181t) from 6,000 ft (1,829m) depth.
TELEPROBE	NAVOCEANO Bay St. Louis, Ms.	20,000 6,096	3,500 1,588	3 5.6	50 amp, 120V regulated power	TV, side scan sonar, magnetometer, stereo-photography	Operational; 24 hrs mobilization

*SEA PROBE consists of a surface ship, drill string and equipment pods; the latter can only operate from its specifically designed ship.

rendezvous point to install the towed system. After rendezvous the system must be loaded aboard, installed, and transit made to the emergency area, before actual searching begins. It is beyond the scope of this survey to conduct a statistical analysis of the likelihood for successful search of a submersible within the life support duration provided by contemporary vehicles. From a practical point of view, the occupants have little or no chance for timely rescue if they must rely upon search and location before retrieval efforts begin.

4.1.2 Self-Propelled, Tethered Systems

This category includes devices that have their own means of propulsion, but are connected by cable to a surface platform. These systems generally obtain their power from the surface platform and provide a real-time, televised picture to the surface operator.

The production of tethered, self-propelled vehicles since the last reporting period has more than doubled. In September 1976 33 of these vehicles were listed. As of June 1978, 75 ROV's are reportedly operating or under construction, these vehicles are listed in Table 4.2. The PAP-104 mine neutralization ROV is so specialized and depth-limited (300 feet) that it is not considered a part of the ROV assets inventory.

The basic tethered, self-propelled vehicle system consists of the vehicle itself (and sometimes an underwater clump or launcher); a cable and a shipboard control/display console. Supporting equipment includes a launch/retrieval device, a cable winch, sheltered areas for the vehicle operators and shipboard components and, if shipboard power is not available or suitable, a power supply unit. As there is no "average" manned submersible, likewise, there is no "average" unmanned submersible. For this reason an individual description of each system is presented. The following discussion deals with various aspects of these vehicles which bear on their applicability to manned submersible search and retrieval.

Operating Depth

Vehicles owned by the non-military sector have a maximum depth capability of 6,600 ft (2,012m), and a mean depth of 3,463 ft (1,055m). Military-owned vehicles have a maximum depth of 20,000 ft (6,096m), and a mean depth of 4,937 ft (1,505m). Every currently operating submersible can be reached by at least one device listed in Table 4.2.

Mobilization Time

In the previous section mobilization time was defined as that time required to load a system's components aboard a truck. This definition is the one used by the operators of TELEPROBE. The operators of ANGUS define it as the time it takes to install their system aboard a ship of opportunity. The definition of mobilization time, therefore, is not standard, and it is subject to a wide variety of factors. The operators of NAVFAC SNOOPY require eight

TABLE 4.2 - REMOTE CONTROLLED VEHICLES

<u>NAME</u>	<u>OPERATING DEPTH (ft/m)</u>	<u>BUILDER</u>	<u>OPERATOR</u>
ANGUS 002	1,000/305	Heriot-Watt University Edinburgh, Scotland	Same
BOCTOPUS	2,170/661	BOC Ltd. London, England	Same
CETUS	1,500/457	Underground Location Services Glasgow, Scotland	Wimpey-Polytechnic Offshore Ltd. Wiltshire, England
CONSUB 1	2,000/610	British Aircraft Corp. Bristol, England	Same
CONSUB 201&202	2,000/610	British Aircraft Corp. Bristol, England	Sub Sea Surveys, Barrow-in-Furness, England
CORD I & II	1,500/457	Harbor Branch Foundation Ft. Pierce, Fl.	Same
CURV II	2,500/762	Naval Undersea Center San Diego, Ca.	Naval Torpedo Station Keyport, Wa.
CURV II	2,500/762	Naval Undersea Center San Diego, Ca.	Same
CURV III	10,000/3,048	Naval Undersea Center San Diego, Ca.	Same
CUTLET (3 each)	1,000/305	Admiralty Underwater Weapons Establish- ment, Portland, England	Same
DEEP DRONE	2,000/610	Ametek Straza El Cajon, Ca.	Supervisor of Salvage Washington, D.C.
ERIC 10	1,640/500	French Navy Toulon, France	Same
ERIC 11	19,685/6,000	French Navy Toulon, France	Same
EV-1	1,500/457	Kraft Tank Co. Kansas City, Mo.	Same
FILIPPO	984/300	Gay Underwater Instruments Trezzano Sul Naviglio, Italy	Same

TABLE 4.2 (Continued)

<u>NAME</u>	<u>OPERATING DEPTH (ft/m)</u>	<u>BUILDER</u>	<u>OPERATOR</u>
MANTA 1.5	4,921/1,500	Institute of Oceanology Moscow	Same
MURS-100	328/100	Mitsui Ocean Development and Engineering Co., Tokyo	Same
OBSERVER DL 1	600/183	G.G. Doris Paris	Same
OBSERVER III	984/300	G.G. Doris Paris	Same
ORCA I	6,000/1,829	Saab-Scania Linkoping, Sweden	Oceaneering International
PAP-104	300/91	Societe ECA Meudon, France	Santa Barbara, Ca.
RCV-150	6,000/1,829	Hydro Products San Diego, Ca. Hydro Products San Diego, Ca. Hydro Products San Diego, Ca. Hydro Products San Diego, Ca. Hydro Products San Diego, Ca. Hydro Products San Diego, Ca. Hydro Products San Diego, Ca. Hydro Products San Diego, Ca. Hydro Products San Diego, Ca. Hydro Products San Diego, Ca. Hydro Products San Diego, Ca. Hydro Products San Diego, Ca. Hydro Products San Diego, Ca.	Various NATO Navies (Over 120 units have been produced) Martech International Houston, Tx. Scandive Stavanger, Norway Taylor Diving and Salvage Belle Chasse, La. Deep Sea Diving Equipment Switzerland Seaway Diving Bergen, Norway (2 each) Martech International Houston, Tx. (3 each) SESAM Paris (2 each) Taylor Diving and Salvage Belle Chasse, La. (5 each) Esso Australia Ltd. Sale, Australia Oceaneering International Santa Barbara, Ca. Hunting Surveys Aberdeen, Scotland
RCV-225	6,600/2,012	Hydro Products San Diego, Ca.	
RECON II	1,500/457	Perry Submarine Builders Riviera Beach, Fl.	

TABLE 4.2 (Continued)

<u>NAME</u>	<u>OPERATING DEPTH (ft/m)</u>	<u>BUILDER</u>	<u>OPERATOR</u>
RECON III	600/183	Perry Submarine Builders Riviera Beach, Fl.	Oceanic Ltd. London, England
RECON V	1,200/366	Perry Submarine Builders Riviera Beach, Fl.	Same
RUWS	20,000/6,096	Perry Submarine Builders Riviera Beach, Fl.	Same
SCARAB I & II	6,000/1,829	NUC Honolulu, Ha.	Same
SCORPIO	3,000/914	Ametek Straza El Cajon, Ca.	AT&T Longlines Bedminster, N.J.
SEA SPY	1,000/305	Ametek Straza El Cajon, Ca.	Stolt-Nielsen Rederi A/S Haugesund, Norway
SEA SURVEYOR	660/220	Underwater and Marine Equipment Ltd. Farnborough Hants, England	Admiralty Underwater Weapons Establishment Portland, Dorset
SMT-1 & 2	1,200/366	Ribikoff Underwater Products Ft. Lauderdale, Fl.	Same
SNOOPY	1,500/457	International Submarine Engineering Ltd. Port Moody, B.C.	Sonarmarine Ltd. Ashford, Middlesex, U.K. (2 vehicles)
SNOOPY	1,500/457	Naval Undersea Center San Diego, Ca.	Same
SNURRE	1,969/600	Naval Undersea Center San Diego, Ca.	Naval Facilities Command Washington, D.C.
SPIDER	820/250	Myren Verksted A/S Oslo, Norway	Continental Shelf Institute Trondheim, Norway
TELESUB	2,000/610	Myren Verksted A/S Oslo, Norway	Same
TOM 300	3,280/1,000	Remote Ocean Systems Escondido, Ca.	Same
TREC	1,200/366	COMEX Marseilles, France	Same
		International Submarine Engineering Ltd. Port Moody, B.C.	Same
		International Submarine Engineering Ltd. Port Moody, B.C.	Martech International Houston, Tx. (3 vehicles)

TABLE 4.2 (Continued)

<u>NAME</u>	<u>OPERATING DEPTH (ft/m)</u>	<u>BUILDER</u>	<u>OPERATOR</u>
TROV BI	1,200/366	International Submarine Engineering Ltd. Port Moody, B.C.	Canada Center for Inland Waters Burlington, Ont.
TROV	1,200/366	International Submarine Engineering Ltd. Port Moody, B.C.	Ocean Systems Inc. Houston, Tx. (charter)
		International Submarine Engineering Ltd. Port Moody, B.C.	J. Ray McDermott, Co. New Orleans, La.
		International Submarine Engineering Ltd. Port Moody, B.C.	Same
U.F.O. 300	984/300	Winn Technology Ltd. Kilbrittain, Ireland	Submersible Television Surveys Ltd. Aberdeenshire, Scotland

hours to load their system aboard a truck, but they caution that the system is not fully mobilized until a trained operator is located and brought aboard to accompany the system. If the SNOOPY system was in the midst of an overhaul, more than eight hours might be required for its mobilization. The larger and deeper CURV system requires 72 hours as mobilization time; this can be reduced to 24 hours in an emergency.

A very practical measurement of CURV III's mobilization time from the point of being requested to the point of being launched for rescue was made during the PISCES III incident. From summons to launch, approximately 66 hours were required; this includes air transit from San Diego to Cork, Ireland and from Cork to the emergency site 250 nautical miles (463km) distant.

In view of the quantity and increasing application of ROV's, it is probably safe to assume that at least one system is operational at any given time somewhere in the world.

Launch/Retrieval

The underwater component(s) or "vehicle" of these systems range from 176 lbs (80kg) to as much as 6,400 lbs (2,903kg). In all other instances, a handling frame of some sort is required of the support craft; the larger the vehicle the more extensive are the handling requirements.

The sea state limitations on launch/retrieval are a direct reflection of the nature and sophistication of the shipboard handling equipment. The unmanned system, in spite of the fact that the retrieval line is always attached, is as vulnerable as the manned system when contact with the sides of the support platform is a possibility. Because most of these systems are designed for deployment from a ship of opportunity, it is not possible to place a sea state limit on the system until the handling gear is specified.

Some indication of sea state limits can be gained from the following operator statements: CONSUB 1 can be launched/retrieved through Sea State 4; DEEP DRONE is designed to be handled up through Sea State 5 if "normal" handling equipment is available which is employed to handle manned submersibles. These vehicles are not the heaviest vehicles operating, but they do fall around the average vehicle weight of 2,118 lbs (961kg). While operational data under heavy sea conditions is sparse, it would appear that up to and including Sea State 5 from any ship of opportunity is a limit for normal operations. In an emergency situation this limit may be exceeded, but not without the possibility of severely damaging the components by slamming the vehicle into the support craft. A further complicating factor accompanying high sea states is the ability of the support craft to maintain station. It may well be that launch/retrieval in Sea State 6 or 7 is possible, but the ship itself cannot keep station to control the vehicle in its search pattern or rescue role.

Speed

The speed of unmanned vehicles is similar to manned vehicles, and ranges, at the surface, from one to five knots (1.8 to 9.3 km/hr). From a search/retrieval consideration, the lowest range of speed is adequate if it can be

maintained at the depth of operation and under prevailing currents. An unmanned vehicle's surface (forward) speed (i.e., with little or no cable drag) decreases considerably with depth. On the individual vehicle description sheets a value is given for the maximum current speed under which a vehicle can maintain forward motion at its operational depth. This same value can be interpreted as its maximum forward speed at operational depth with no currents.

The reduction in speed with depth does not, in most open ocean areas, detract from the ROV's capability to perform as a submersible search/retrieval asset, because 0.5 to 1 knot currents are not generally encountered except in areas such as the Gulf Stream or Kuroshio Current. Areas such as the North Sea are a different situation. In the Frigg field, for example, current speeds (tidally induced) of 0.6 knots (1.1 km/hr) and greater are common, while farther south in the Deborah, Dottie and Lemon Bank fields up to 3 knots (5.6 km/hr) of current are present. In such areas the effectiveness of the remotely operated vehicles (and manned as well) is reduced considerably; in some instances completely.

Maneuverability

All but a few vehicles are capable of two translation motions and one rotational motion; these are thrust (forward/reverse) and heave (up/down); and yaw (left-right) heading changes, respectively. These motions are provided by the arrangement of two horizontal or forward thrusters and one vertical thruster. By adding a forth lateral or side thruster, a third translational motion is obtained: sway or sidle. Pitch motion is not common and can only be found on the CONSUB vehicles where two forward/aft-mounted vertical thrusters can impart pitch to the vehicle by operating in opposing directions. By designing its television camera mounting such that it can be trained ± 90 degrees from the horizontal plane, the manufacturers of RCV-225 have provided a substitute for pitching the entire vehicle. No unmanned vehicle is known to have a roll motion capability.

The umbilical cable offers an obvious potential for fouling, but this is a constraint under which the operator must work and he has no choice but to be selective in his job applications. From a search/rescue point of view, the maneuverability of unmanned, self-propelled vehicles appears more than adequate to the task.

Instrumentation

The instruments discussed here are those applicable to search and retrieval of a manned submersible. These tasks imply location of the submersible, evaluation of the predicament (e.g., source and nature of the entanglement), and the capability for taking corrective action, such as cutting a cable or attaching a line for surface retrieval. The instruments listed in Table 4.3 are those considered applicable to these tasks and are a standard piece of onboard equipment. There are numerous equipment options on virtually all unmanned vehicles, however, these options are not listed because they reflect what the vehicle could be, not what it is.

ROV WORK INSTRUMENTATION

ROV	VIEWING/PHOTOGRAPHY				SONAR			
	STILL	STEREO	CINE	MANIPU- LATOR	ECHO	SCANNING	HOMING	
	TV CAMERA	CAMERA	CAMERA		SOUNDER			
ANGUS 002	X	X		X (2ea)			X	
BOCTOPUS	X (2ea)				X			
*CETUS	X (2ea)	X			X	X		
CONSUB 1	X (2ea)		X					
CONSUB 201&202	X (2ea)		X					
CORD I & II	X			X	X	X		
CURV II	X (2ea)	X		X	X	X	X	
CURV III	X	X		X	X	X	X	
DEEP DRONE	X (2ea)	X				X	X	
ERIC II	X		X	X (2ea)	X	X		
ERIC 10	X	X		X	X	X	X	
EV-1	X							
FILIPPO	X							
MANTA 1.5	X			X				
MURS-100	X			X				
*OBSERVER DL 1	X							
*OBSERVER III	X (2ea)			X				
ORCA I	X (2ea)		X	X (3ea)	X			
PAP-104	X							
RCV-150	X							
RCV-225	X							
RECON II	X			X				
RECON III	X							
RECON V	X			X				
RUWS	X	X		X (2ea)	X	X	X	
SCARAB I & II	X (2ea)	X		X (2ea)	X	X	X	
SCORPIO	X			X		X	X	
SEA SPY	X							
SEA SURVEYOR	X							
SMT 1 & 2	X			X (2ea)	X			
SNOOPY (Electric)	X		X					
SNOOPY (NAVFAC)	X		X			X		
SNURRE	X (2ea)		X	X (2ea)	X		X	
SPIDER	X				X			
TELESUB 1000	X (2ea)				X			
TOM 300	X (2ea)	X		X				
TREC	X				X			
TROV B1	X			X	X			
*TROV	X			X (2ea)	X			

*No details available

All operating unmanned vehicles have a closed circuit television system. Combining this real-time viewing capability with the excellent maneuverability provides an ideal means of inspecting and evaluating a submersible's situation. Locating the submersible may be a more difficult proposition. The Hydro Product's low light level SIT television camera's viewing range is, in clear water with no ambient light, 23 to 33 feet (7 to 10m). While it is possible that an unmanned device will eventually find a target by systematically searching within its 33 feet viewing range, it is not practical to count on this approach considering the limited life support available to the submersible occupants. There are three potential means of reducing the search time: 1) by visually following a marker buoy attached to the vehicle, or 2) by homing in on the submersible's pinger, or 3) by searching for the submersible with scanning sonar. The first of these methods, following a marker buoy, is not quite as simple as first appears because of the precise control needed to maintain visual (TV) contact with the marker line. Buoyed lines rarely remain perfectly vertical and they are subject to lateral excursions which may transport the line out of the field of view. While this location method is feasible, it is not always operationally practical. The best method of location is homing on an active acoustic target attached to the submersible.

Scanning and CTFM sonar is also quite effective, but, if the submersible is entangled in a ship or other large structure, differentiating the submersible's acoustic reflection from the wreck may be time-consuming, if not impossible. The best method, therefore, is homing on an active target. Table 4.3 shows that only 11 out of 75 vehicles have this capability. Consequently, while all unmanned vehicles are potentially excellent evaluation tools, only 14 percent have the capability of applying this asset in the most effective manner to a stricken manned submersible.

Manipulators

The capability to provide corrective action resides in the vehicle's ability to manipulate or cut a line or cable, or to attach a retrieving line from the surface. In either case a grasping ability is a major asset. Approximately 34 percent of the unmanned vehicles have a manipulator capability. Four vehicles (RECON II, SCARAB I & II and RCV-150) provide cable cutting terminations as standard equipment. RECON II has the capability of cutting through a 5/8 in. (1.6cm) diameter wire rope.

The most applicable and immediate role ROVs can play is to attach a lift line; this task also requires a manipulator. In view of the unmanned vehicles' maneuverability, a manipulator not anymore complex than RECON II's (linear extension, wrist rotate, claw open/close) could satisfy the manipulative function. However, the depth of operation, diameter of the retrieving cable and prevailing current strength may place severe limits on the ROV's application.

Crew

For routine operations the support crews range from one to seven in numbers with three to four being average. The CURV-type vehicles require up to ten personnel in an emergency. Commercial operators of unmanned vehicles do not

specifically define a routine operation; it is assumed that eight to ten hours is routine. In an emergency situation a 24 hour capability is required; if the CURV vehicles are used as a guide, then somewhere between four to six personnel may be necessary to operate and support a specific vehicle over a 24 hour period.

Navigation

Submerged navigation of unmanned vehicles is similar to those described in Section 5.5 for manned vehicles. Descriptions of each vehicle's approach to navigation are presented on the individual data sheets.

ANGUS 002

Operating Depth: 984 ft (300m)

Dimensions (LxWxH): 74 in. x 41 in. x 51 in. (225cm x 127cm x 135cm)

Weight (dry): 1,543 lbs (700kg)

Speed: (Max. Surface) 1.5 knots (2.8 km/hr)
(Max. Depth) 1.0 knot (1.85 km/hr)

Structure: Open tubular aluminum framework. Supports and encloses all components. Eight inch (20cm) diameter polypropylene floats are contained within a glass reinforced casing atop the vehicle.

Buoyancy: Positive buoyancy is provided by polypropylene floats and parts of the tubular framework which is pressure compensated.

Power Requirements: All electrical power is supplied by a 3-phase, 415/240 V, 50Hz, 20 kVA diesel generator.

Propulsion: Two, 4½ hp horizontal thrusters mounted p/s on the stern, and four, 1½ hp vertical thrusters ducted within each corner of the upper casing.

Instrumentation: One TV camera, one 35mm still camera, one Super 8 cine camera, two 600 and one 500 watt quartz iodide lights of infinitely variable intensity, hydrophone (25 kHz), wide band hydrophone (0-200 kHz), magnetic compass, echo sounder, pressure transducers.

Navigation: A two-transponder relative positioning system has been developed and tested. Repeatability of less than 1.5 meters (4.9 ft) on a 1 km (0.5 nm) baseline was obtained.

Shipboard Components: Diesel generator, Earth Leakage Protection Unit (circuit breakers), control console, (CCTV monitor, compass repeater, roll & pitch indicators, buoyancy and trim meters, depth readout, voltage and current monitors), cable reels (400 meters/1,312 ft total), tool box, navigation control console and underwater transponders are essential.

Support Ship Requirements: Any craft in excess of 12 meters (39 ft) length and equipped with a derrick capable of lifting the vehicle.

Operation/Maintenance Crew: Two: one engineer, one technician

Total Shipping Volume: 783 ft³ (22m³)

Total Shipping Weight: 3.5 tons (3.2t)

Status: Operational

Builder: Dept. of Electrical & Electronic Engineering
Heriot-Watt University
31-35 Grassmarket, Edinburgh EH1 2HT
Scotland

Operator/Point-of-Contact: Robin T. Holmes
(Address same as above)
Telephone: 031-225-8432 ext. 104

BOCTOPUS

Operating Depth: 2,170 ft (661m)

Dimensions (LxWxH): 126 in. x 84 in. x 66 in. (320cm x 213cm x 168cm)

Weight (dry): 2,000 lbs (907kg)

Speed: 0.5 kts (0.9km/hr) at 1,150 ft (350m) in 2 kt (3.7km/hr) current.

Structure: Rectangular-shaped open steel framework encloses and supports all components. Top half of vehicle is enclosed by a fiberglass fairing.

Buoyancy Control: Dives with 20 lbs (9kg) positive buoyancy which is provided by spheres enclosed in the fiberglass fairing.

Power Requirements: Total power of 33 KVA is supplied by a self-contained diesel generator.

Propulsion: Five thrusters total. Two (10hp) horizontal thrusters located aft on the keel. Two (4hp) vertical thrusters located port/starboard amidship. One (3hp) lateral thruster located on the keel forward.

Instrumentation: Echo sounder, two television cameras (one fixed; one on pan/tilt mechanism). Vehicle is designed to accommodate and transmit data from a side scan sonar and sub-bottom profiler. Optional equipment includes cine and still camera and manipulator.

Navigation: Magnetic compass, transponder, pressure/depth indicator.

Shipboard Components: Diesel generator, hydraulic crane and winch, control cabin.

Support Ship Requirements:

Operating/Maintenance Crew:

Total Shipping Volume:

Total Shipping Weight:

Status: Operational

Builder: BOC, Limited

London, England

Operator/Point-of-Contact: Charles P. Quartley
BOC, Limited
Advanced Projects Group
Manor Royal
Crawley, West Sussex RH102LW
England
Telephone: (0293) 28844
Telex: 87123 EDHIVAC Crawley

CONSUB 1

Operating Depth: 2,000 ft (610m)

Dimensions (LxWxH): 107 in. x 72 in. x 57 in. (271cm x 182cm x 145cm)

Weight (dry): 3,000 lbs (1,360kg)

Speed: (Max surface) 2.5 kts (4.6 km/hr)

(Max Operating Current) 2 kts (3.7 km/hr) at 2,000 ft. (610m)

Structure: Tubular aluminum alloy HE 130

Buoyancy: Two cylindrical, pressure-resistant, fiberglass cylinders provide a positive buoyancy of 40 lbs (18kg) when vehicle is submerged

Power Requirements: 240 V 50 Hz single phase 3 KVA, 415 V 50 Hz 3-phase 50 KVA (to the control cabin transformer). If the latter is not available a diesel generator can be used. Surface transformer converts supply voltage to 415 V/1000 V 3-phase for transmission to vehicle.

Propulsion: Two lateral and two vertical fixed, reversible thrusters. All are electro-hydraulically powered, 5 hp each, and capable of independent operation.

Instrumentation: Compass, inclinometer, depth gauge, two TV cameras (1 color; 1 black and white), stereo camera system, rock drill capable of taking a 0.5 in. (1.3cm) diameter 5 in. (13cm) long core. Stereo and TV cameras are mounted on a pan and tilt unit which trains ± 150 degrees in azimuth and tilts $+30$ degrees to -90 degrees from the horizontal.

Navigation: No underwater positioning system in operational configuration, can be configured to utilize the SCANTIE System.

Shipboard Components: Control console (2 TV monitors; vehicle/instrument controls), Transformer, System Distribution Box (connects transformer, ship junction box and consoles) Ship Junction Box (terminates umbilical cable of support craft) and Faking Frame (for storage and deployment of umbilical).

Support Craft Requirements: Launch/retrieval system capable of supporting vehicle dry weight. Freeboard not to exceed 12 ft (3.7m). Deck space: 10 ft x 10 ft (3m x 3m) clear space with tiedowns for vehicle; area of 20 ft x 20 ft (6m x 6m) required for umbilical cable faking frame. Cabin space: 1) must be large enough to contain a 7 ft (2.1m) long bench for control console at which two operators sit, and must also provide a view of operational deck area; 2) bulkhead area 3 ft x 4 ft (0.9m x 1.2m) for distribution box; 3) deck space in cabin of 2 ft x 2 ft (0.6m x 0.6m) for transformer and 4) an access port of 5 in. (12.7cm) diameter is required for electrical service cables.

Operating/Maintenance Crew: Three to four

Total System Shipping Volume: NA

Total System Shipping Weight: 6,100 lbs (2,767kg) (approximate)

Status: Operational. Has conducted a variety of commercial and scientific in the U.K. offshore area.

Builder: British Aircraft Corp. Ltd.
Bristol, England

Operator / Point-of-Contact: Electronic & Space Systems Group
British Aircraft Corp. Ltd.
GPO Box 77
Filton House, Bristol BS99 FAR
England
Telephone: Bristol (0272) 693831 ext. 811
Telex: 44188

CONSUB 201 & 202

Operating Depth: 2,000 ft (610m)

Dimensions (LxWxH): 145 in. x 84 in. x 69 in. (368cm x 213cm x 175cm)

Weight (dry): 6,393 lbs (2,900kg)

Speed: (Max. Surface) 2.5 kts (4.6 km/hr)

(Max. Operating Current) 2 kts (3.7 km/hr) at 2,000 ft

Structure: Rectangular-shaped tubular aluminum alloy (HE 130) encloses and supports all components.

Buoyancy: Syntactic foam blocks provide positive buoyancy.

Power Requirements: 380/415/440 V 50/60 Hz 3-phase 125 KVA (to control cabin transformer)

Propulsion: Four fixed, reversible, electric thrusters with Kort nozzles each of 12.5 hp movement. A TV camera is mounted on a rotating platform stabilized in azimuth relative to rest of vehicle, the controls are arranged such that the vehicle will travel in the compass bearing in which the operator points the camera.

Instrumentation: Two TV cameras, stereo camera system mounted on a pan and tilt mechanism similar to CONSUB 1. Depth sensor, magnetic compass. Special payload arrangements will allow a wide variety of work tools and sampling devices. In the event of power loss to the vehicle, a self-powered transponder and flashing light is activated. Nine, 1,000 watt quartz iodide lights.

Navigation: Visual sighting and magnetic compass. Vehicle space and electrical connectors are available to accommodate any of the conventional bottom-mounted or surface-tracking navigation systems.

Shipboard Components: Same as CONSUB 1 except that a mechanical cable handling unit replaces the faking frame.

Support Craft Requirements: Clear deck space (with tie-downs): 15 ft x 18.4 ft (4.6m x 5.6m) for vehicle; 20 ft x 6.5 ft (6m x 2m) for cable handling device. Derrick or crane capable of lifting vehicle with an outreach of 6.5 ft (2m) from the support craft. Two cabins, each 19.7 ft x 8 ft x 8.5 ft (6m x 2.4m x 2.6m). Station Keeping requirements dependent upon depth of vehicle and strength of current.

Operating/Maintenance Crew: Four

Total Shipping Volume: 1,624 ft³ (46m³), not including optional diesel generator.

Total Shipping Weight: 39,374 lbs (17,860kg)

Status: 201: Operational - 202: Construction

Builder: British Aircraft Corp.
Bristol, England

Operator/Point-of-Contact: 201: Subsea Surveys Ltd.
127 Duke Street
Barrow-in-Furness
Cumbria, England
Telex: 65248

202: British Aircraft Corp. Ltd.
Electronic & Space Systems Group
GPO Box 77
Filton House, Bristol BS99 FAR, England
Telephone: Bristol (0272) 693831 Ext. 81
Telex: 44188

CORD I & II

Operating Depth: 1,500 ft (457m); 2,000 ft (610m) goal

Dimensions (LxWxH): 68 in. x 41 in. x 55 in. (173cm x 104cm x 140cm)

Weight (dry): 720 lbs (327kg)

Speed: (Max. Surface) 5 kts (9 km/hr)

(Max. Operating Current) 2 kts (3.7 km/hr) at 1,500 ft

Structure: A U-shaped 10 in. (25cm) aluminum tube provides flotation and serves as storage and protection for the bulk of the electronics. The base of the vehicle consists of two rectangular oil-filled pods which serve as the hydraulic reservoir and as mounting locations for electronic and hydraulic components.

Buoyancy: U-shaped, 10 in. (25cm) diameter, pressure-resistant, aluminum tube provides positive buoyancy when surfaced. Buoyancy submerged can be controlled by + 15 lbs (6.8kg) through displacement of oil into and out of a soft bladder.

Power Requirements: 5 KW 480 V 3-phase 60 Hz provided by an alternator in SEA GUARDIAN (its support craft) which is hydraulically powered by a 115 hp Ford diesel engine. A 0.35 in. (0.9cm) diameter, 1,850 ft (564m) long, armored, coaxial cable serves as the umbilical between support craft and vehicle.

Propulsion: Four hydraulically-powered, fixed, reversible propellers driven by a 3 hp hydraulic motor. Two thrusters supply forward-aft motion (thrust), one provides vertical motion (heave) and one provides lateral motion (yaw). All have continuously variable speed control.

Instrumentation: Television and light on pan & tilt mechanism (360 degrees azimuth; 110 degrees downward from the horizontal), current speed sensor, temperature sensor, echo sounder. Magnetic compass, pressure/depth transducer, scanning sonar (360 degree scan, 200 kHz search; 500 kHz local) with CRT display. Manipulator: hydraulically-powered, two degrees-of-freedom, scissors-type claw.

Navigation: CORD is equipped with a 25 kHz pinger which can be powered from the surface or is self-powered and pings at repetition rate of once/second. Its support craft deploys three hydrophones, one mounted on the starboard forward quarter, one amidships portside, and one on the starboard side astern. The three hydrophones receive the outgoing ping and onboard electronics process the signal by triangulation to provide a CRT display showing the pinger's position relative to the three hydrophones. Accuracy of CORD's position relative to its support craft had not been determined at the time of this survey.

Shipboard Components: CORD is deployed from an aluminum surface utility craft, SEA GUARDIAN, which has the following dimensional characteristics:

Length:	23 ft (7m)	Speed (loaded):	8 kts (14.8 km/hr)
Beam:	9 ft (2.7m)	Range:	60 nm (111 km)
Draft:	2 ft 1 in. (0.6m)	Weight (loaded):	4.5 tons (4.1t)

All controls and displays for the operation and monitoring of CORD are aboard SEA GUARDIAN. Power is provided by a 115 hp Ford diesel engine which drives three hydraulic pumps which power the main hydrostatic transmission propulsion system, a 5 KW alternator and bow and stern thrusters as well as a line hauler and storage reel. A dynamic positioning system, within an enclosed cabin, maintains SEA GUARDIAN in position over CORD. At present, CORD can only be fully deployed and operated from SEA GUARDIAN.

Support Craft Requirements: At present CORD can only be fully deployed and operated from SEA GUARDIAN.

Operating/Maintenance Crew: Three

Total Shipping Volume: 49.3 yd³ (37.5m³) approximate

Total Shipping Weight: 4.9 tons (4.4t) approximate

Status: Undergoing operational sea trials; has dived to 1,000 feet (305m).

Builder: Harbor Branch Foundation, Inc.

Rt. #1, Box 196

Ft. Pierce, Fl. 33450

Operator/Point-of-Contact: Same as above

Telephone: (305) 465-6400

CURV II

Operating Depth: 2,500 ft (762m)

Dimensions (LxWxH): 180 in. x 72 in. x 72 in. (457cm x 183cm x 183cm)

Weight (dry): 3,450 lbs (1,565kg)

Speed: (Max. Surface) 4 kts (7.4 km/hr)

(Max. Operating Current) NA

Structure: Rectangular-shaped open aluminum framework encloses and supports all components. Syntactic foam blocks are affixed atop the framework.

Buoyancy: Syntactic foam blocks provide slight positive buoyancy submerged.

Power Requirements: 440 VAC, 120 VAC 3-phase 50 KW. A portable, 60 KW diesel generator supplies all power to the system.

Propulsion: Three, 10 hp, pressure-compensated, electric motors provide power to three propellers. Two provide forward-reverse motion and one provides vertical motion. All are capable of independent operation.

Instrumentation: Television (2 ea.), 35mm still camera, lights, altimeter, depthometer, magnetic compass, active and passive CTFM sonar (AMETEK Straza Mfg.). Manipulator, hydraulically-powered, three degrees-of-freedom, circular-type (torpedo grasping) claw.

Navigation: By compass bearing and visual sighting. Can interrogate bottom-mounted transponder to obtain relative position. Can locate pinger and "home" in on target.

Shipboard Components: Control/display console (in a portable van), power supply (generator) and conversion equipment, and surface handling equipment.

Support Ship Requirements: Station-keeping capability and cable handling area away from screws. Deck space for seven items approximately 75 to 120 ft² (7 to 11.2m²) each.

Operational/Maintenance Crew: Seven normally, ten in an emergency mission

Total Shipping Weight: 26 tons (23.6t) (not including handling crane)

Total Shipping Volume: 4,500 ft³ (127.4m³). For operations to 1,500 ft (457m) the total system (not including handling crane) can be loaded aboard on C-141 aircraft on known ship of opportunity. For emergency operations on unknown ship of opportunity, two C-141s are required.

Status: Operational. Two identical CURV IIs are in operation, one at NUC, San Diego and one at the Naval Torpedo Station, Keyport, Wa.

Builder: Naval Undersea Center

San Diego, Ca.

Operator/Point-of-Contact: Mr. H.R. Talkington
Naval Undersea Center (Code 65)
San Diego, Ca. 92132
Telephone (714) 225-7811
Autovon: 933-7147

Commanding Officer
Naval Torpedo Station
Keyport, Wa. 98345
Telephone (206) 326-2511/2512/2514
Autovon: 744-2511/2512/2514

CURV III

Operating Depth: 10,000 ft (3,048m)

Dimensions (LxWxH): 150 in. x 78 in. x 78 in. (457cm x 183cm x 183cm)

Weight (dry): 4,000 lbs (1,814kg)

Speed: (Max. Surface) 4 kts (7.4 km/hr)
(Max. Operating Current) NA

Structure: Same as CURV II

Buoyancy: Same as CURV II

Power Requirements: Same as CURV II

Propulsion: Same as CURV II

Instrumentation: Same as CURV II

Navigation: By compass heading and visual sighting. The support craft, YFNX-30, is equipped with a Boat-Mounted Acoustic Locating Device (BALD) which monitors CURV III's relative bearing during a dive.

Shipboard Components: Same as CURV II

Support Ship Requirements: Same as CURV II. For local area operations, the YFNX-30 serves as its support craft. YFNX-30 has the following characteristics: Length 110 ft (33.5m), beam 34 ft (10.4m), draft 5 ft (1.5m), freeboard 6.5 ft (2m), speed 5.5 kts (10.2 km/hr).

Operational/Maintenance Crew: Same as CURV II

Total Shipping Weight: Same as CURV II

Total Shipping Volume: Same as CURV II

Status: Operational

Builder: Naval Undersea Center
San Diego, Ca.

Operator/Point-of-Contact: Mr. H.R. Talkington
Naval Undersea Center (Code 65)
San Diego, Ca. 92132
Telephone (714) 225-7811
Autovon: 933-7811

DEEP DRONE

Operating Depth: 2,000 ft (610m)

Dimensions (LxWxH): 84 in. x 54 in. x 48 in. (213cm x 137cm x 122cm)

Weight (Dry): 1,600 lbs (726kg)

Speed: (Max. Surface) 3.5 kts (6.5km/hr)

(Max. Operating Current) 2 kts (3.7km/hr) at 2,000 ft (estimated)

Structure: Two, pressure-resistant flotation tanks atop of - and enclosed within - an open, tubular aluminum framework.

Buoyancy: Positive buoyancy of 45 lbs (20kg) is provided by the flotation tanks when submerged. Negative buoyancy is dynamically-provided by the thrusters.

Power Requirements: 115 VAC 1-phase 2 KVA, 440 VAC 3-phase 10 KVA. Umbilical consists of 3,000 ft (914m) long, 0.75 in. (1.9cm) diameter coaxial cable with strength member. A diesel motor generator provides all power required to operate the vehicle system.

Propulsion: Three thrusters, two are for forward-aft propulsion (thrust and yaw) and one is for vertical propulsion (heave). Each motor is fixed, reversible, shrouded by a Kort Nozzle and rated at three shaft horsepower at 1,725 rpm.

Instrumentation: Two TV cameras, one is fixed and one is mounted on a pan and tilt mechanism, 80mm still camera with strobe light, CTFM sonar with transponder interrogation and pinger location capabilities, altimeter, depth meter.

Navigation: The CTFM sonar is designed to interrogate a bottom-mounted (ATNAV) transponder and, using it as a benchmark, can conduct search patterns out to 3,000 ft (914m). The sonar can also interrogate more than one transponder to establish its position. A locator system aboard the surface craft can obtain the vehicle's relative range and bearing.

Shipboard Components: Control console, control cable and basket, support line and A-frame, vehicle locator, diesel motor generator, support spare parts.

Support Ship Requirements: Lift boom of one ton (0.9t) capacity, deck capstan for retrieval of umbilical, station-keeping ability if conducting underway operations.

Operation/Maintenance Crew: Four man (minimal - more depending on nature and length of task).

Total Shipping Weight: 5.5 tons (5t)

Total Shipping Volume: 4,000 ft³ (113m³). Packaged for shipment in two standard LD-9 air cargo containers.

Status: Operational, on standby for emergency calls.

Builder: AMETEK, Straza Division

El Cajon, Ca. 92022

Operator/Point-of-Contact: Thomas B. Salmon
Naval Sea Systems Command
Supervisor of Salvage
Washington, D.C. 20362
Telephone: (202) 697-7403
Autovon: 227-7403

ERIC II

Operating Depth: 6,000m (19,685 ft)

Dimensions (LxWxH): Fish: 500cm x 300cm x 180cm (197 in. x 118 in. x 71 in.)

Clump: 640cm x 370cm x 260cm (252 in. x 146 in. x 102 in.)

Weight (Dry): Fish: 5t (5.5 tons)

Clump: 2.5 to 4t (2.75 to 4.4 tons)

Structure: Teardrop configuration overall. All components are enclosed within a fiberglass framing. A clump, PAGODE, is employed to protect ERIC II during launch/retrieval and to keep the umbilical taut while the fish operates from a 300m (984 ft) long cable between it and the PAGODE.

Power Requirements: Fish power (115 V single phase, 400 Hz, 100 KW max.) is supplied by a diesel generator.

Propulsion: Six thrusters provide six degrees of maneuvering freedom.

Instrumentation: Cine camera, scanning sonar, CCTV (head-following) gyrocompass and vertical gyro, echo sounder, depth sensor, two manipulators with force feedback.

Navigation: A bottom-mounted transponder navigation system (11 and 16 KHz) can provide fish position accuracies of +5m (16.4 ft) with 20-second updates. The navigation computer simultaneously handles the ship and fish navigation.

Shipboard Components: Control/display console (in a portable van), cable and fish handling equipment, acoustic navigation equipment.

Support Ship Requirements: Dynamic positioning capability.

Operating/Maintenance Crew: Two operators are required to run the system. One operator controls the fish, the second operator maintains the support ship directly over the PAGODE.

Total Shipping Volume: Approximately 222m³ (7,838 ft³) not including the technical shelter or diesel generator.

Total Shipping Weight: Approximately 47.5t (52.4 tons) not including the technical shelter or diesel generator.

Status: Construction

Builder: CERTSM

D.C.A.N. Toulon
France

Operator/Point-of-Contact: M. le Capitaine de Corvette
Commandant la Division des
S.M. d'Intervention et du Bathyscaphe
GISMER
83-800 Toulon-Naval-France
Telephone: (94) 24 9100

ERIC 10

Operating Depth: 500m (1,640 ft)

Dimensions (LxWxH): 400cm x 200cm x 200cm (158 in. x 79 in. x 79 in.)

Weight (dry): 2.8t (3.1 tons)

Speed: (Max. Surface) 4 kts (7.4 km/hr)

(Max. Operating Current) 2.0 kts (3.7 km/hr)

Structure: Rectangular shape composed of open aluminum framework which encloses and supports all components.

Buoyancy: The vehicle is 110 lbs (50kg) positively buoyant

Power Requirements: 60 Hz, 3-Phase, 440 VAC 60 KVA

Propulsion: Three thrusters, two provide thrust and yaw and one provides vertical motion. All thrusters are reversible; have continuously variable speed control (0 to 380 rpm) and are capable of independent operation.

Instrumentation: TV on pan and tilt mechanism, six lights, still camera, depth gauge, CTFM sonar, inclinometer (pitch; roll) downward-looking echo sounder, magnetic compass, magnetometer. One manipulator with five degrees-of-freedom, parallel jaws-type claw. Six, 400 watt quartz iodide lights. Two surface flashing lights.

Navigation: Compass heading, visual sighting and by interrogation of transponders with the CTFM sonar.

Shipboard Components: Control/Display console (in portable van), cable and reel winch, launch/retrieval crane, diesel generator.

Support Ship Requirements: Deck space for van and component storage.

Operation/Maintenance Crew: Five

Total Shipping Weight: 11 tons (10t)

Total Shipping Volume: 1,588 ft³ (45m³)

Status: Operational

Builder: Centre d'Etudes et de Recherches Techniques Sous-Marines

D.C.A.N. Toulon

France

Operator/Point-of-Contact: M. le Capitaine de Corvette

Commandant la Division des

S.M. d'Intervention et du Bathyscaphe

GISMER

83800 TOULON - NAVAL - FRANCE

Telephone: (94) 24 9100 - poste 21090

EV-1

Operating Depth: 1,500 ft (457m)

Dimensions (LxWxH): 52 in. x 32 in. x 24 in. (132cm x 81cm x 61cm)

Weight (Dry): Vehicle - 2351 lbs (107kg)

Launcher (if used) - in design stage

Speed: (Max. Operating Depth) 1.5 knots

Structure: Two syntactic foam cylinders strapped to a welded tubular steel frame support motors, camera/electronics pressure housing, and other associated hardware.

Buoyancy Control: Vehicle operates neutrally buoyant with additional buoyancy available for up to 50 lbs of accessory equipment.

Power Requirements: 220 or 440 VAC 3-phase 60Kz 5 KW Maximum.

Propulsion: Three fixed reversible hydraulic motors, one stern mounted, one lateral, and one vertical thruster, provide thrust, yaw, and heave.

Instrumentation: Fixed TV camera, one 100 watt tungsten halogen light, compass, transducer for depth, salt water intrusion, and hydraulic system temperature.

Navigation: By compass heading and visual sighting.

Shipboard Components: Control console, power supply, winch.

Support Ship Requirements: Enclosed area for control console, 3-phase 60Hz 200 or 440 V generator.

Operating/Maintenance Crew: Two or three depending upon length of task.

Total Shipping Volume: NA

Total Shipping Weight: NA

Status: Operational (second vehicle complete in July 1978)

Builder: Ocean Systems Division

Kraft Tank Co.

2921 East 88th Terrace

Kansas City, Mo.

Telephone: (816) 561-0111

Operator/Point-of-Contact: Undetermined at present/contact builder

FILIPPO

Operating Depth: 300m (984.3 ft)

Dimensions: Spherical shape nominal 50cm (19.7 in.) diameter

Weight (Dry): 80kg (176.4 lbs)

Speed: Can work at operating depth in 0.5kt (.93km/hr) current.

Structure: Two fiberglass demispheres enclose all components. The hull is penetrated by two parallel windows oriented 30 degrees downward from the horizontal through which the TV camera and still camera view.

Buoyancy Control: A droppable weight of 20kg (94.1 lbs) and a guard chain provide the vehicle with 0.5kg (1.1 lbs) negative buoyancy. When the chain rests on the bottom about 3kg (6.6 lbs) of positive buoyancy is obtained.

Power Requirements: Self-powered with rechargeable lead acid batteries. About 8 hours operational time is provided.

Propulsion: Four fractional hp electric motors provide forward/reverse, vertical and lateral movement and yaw control.

Instrumentation: Magnetic compass, depth sensor, TV camera, 55 watt halogen light. Optional equipment includes still camera and flood light and manipulator.

Navigation: Magnetic compass and visual.

Shipboard Components: Cable and winch 45kg (99.2 lbs) total weight, 54cm x 50cm x 40cm (21.3 in. x 19.7 in. x 15.7 in.) H x W x D. Control/display console weighing 15kg (33 lbs) and 54cm x 38cm x 32cm (21.3 in. x 15 in. x 12.6 in.) H x W x D.

Support Ship Requirements: Deck space of approximately 2.5m² (26.9 ft²)

Operating/Maintenance Crew: One

Total Shipping Volume: Approximately 410,864cm³ (14.5 ft³)

Total Shipping Weight: 130kg (286.7 lbs)

Status: Operational

Builder: Gay Underwater Instruments

Via Papa Giovanni

20090 Trezzano Sul Naviglio, Italy

Operator/Point-of-Contact: Ing. Guido Gay

(Address same as above)

MANTA 1.5

Operating Depth: 4,921 ft (1,500m)

Dimensions (LxWxH): 78 in. x 62 in. x 40 in. (198cm x 158cm x 107cm)

Weight (dry): 2,200 lbs (998kg)

Speed: (Max. Surface) 3 knots (5.5kt/hr)
(Max. Operating Current) NA

Structure: Frame Construction

Buoyancy: 11 lbs (5kg) positively buoyant underwater

Power Requirements: 380 BAC 3-phase 50 Hz

Propulsion: Four thrusters, two provide fore-aft thrust and yaw, two provide vertical motion (heave). All are fixed, reversible and 1.5 hp each.

Instrumentation: Television, lights (3 at 500 watts), manipulator with 5 degrees-of-freedom, capable of 10kg (22 lbs) lift capacity and has various types of claws, side scan sonar.

Navigation: TV provides for visual navigation

Shipboard Components: Cable

Shipboard Requirements: NA

Operator/Maintenance Crew: Three

Total Shipping Weight: 4 tons

Total Shipping Volume: 20m³

Status: Operational

Builder: Academy of Sciences USSR
Moscow

Operator/Point-of-Contact: Mr. A. Monin, Director
Institute of Oceanology USSR
1 Letnay St., Moscow 109387
Telephone: 233-55-76
Cable: G-387 OCEANOLOGIYA

MURS-100

Operating Depth: 328 ft (100m). Emergency dive to 492 ft (150m).

Dimensions (LxWxH): 100 in. x 74 in. x 49 in. (255cm x 189cm x 150cm).

Weight (dry): 1,984 lbs (900kg).

Speed: (Max. Surface) 2 kts (3.7 km/hr).

(Max. Operating Current) 2.5 kts (4.6 km/hr) at 328 ft (100m) depth.

Structure: An acrylic plastic, tear drop-shaped shell enclosed and supports a pressure-resistant inner shell consisting of a transparent acrylic plastic hemisphere joined to a steel sphere. The inner shell contains a TV camera and its telemetry control unit and the thruster orientation units. Metallic skids support the vehicle on deck or when bottomed.

Buoyancy: The vehicle is 13 lbs (6kg) positively buoyant when submerged.

Power Requirements: 440 VAC, 60 Hz, 3-phase, 30 KVA.

Propulsion: Two, oil-filled, reversible thrusters are mounted port/starboard amidships (1 on each side). Each thruster can be rotated ± 90 degrees in the vertical plane and each is rated at 2 hp (1.5 KW)

Instrumentation: One color TV with mirror pan and tilt unit. Eight 500 watt halogen lights, compass, inclinometer (pitch), depth gauge, speedometer, transponder. A bilateral, force feedback manipulator is planned for installation by March 1977.

Navigation: Compass heading and visual sighting. A transponder on the vehicle is interrogated to provide slant-range and bearing from the support ship.

Shipboard Components: Control/display console; power panel, cable winch.

Support Craft Requirements: One (1) ton (0.9t) capacity boom with 6 ft (2m) out-reach for launch/retrieval of vehicle. Deck space of 20 ft x 20 ft (6m x 6m).

Operation/Maintenance Crew: Three to four.

Total Shipping Volume: Approximately 989 ft³ (28m³).

Total Shipping Weight: Approximately 5 tons (4.5t).

Status: Operational.

Builder: Mitsui Ocean Development & Engineering Co., Ltd.
Tokyo, Japan

Operator/Point-of-Contact: New Products Center
Mitsui Ocean Development & Engineering Co., Ltd.
2-5 Kasumigaseki 3-Chome
Chiyoda-Ku Tokyo, Japan
Telephone: Tokyo (03) 581-2301
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ORCA I

Operating Depth: 700m (2,300 ft)

Dimensions (LxWxH): 3.5m x 2m x 2m (11.5 ft x 6.6 ft x 6.6 ft)

Weight (Dry): 2,721kg (6,000 lbs)

Speed: NA

Structure: Open, rectangular, metallic framework encloses and supports all components. Syntactic foam blocks are attached to the top of the frame.

Buoyancy Control: Syntactic foam is adjusted to provide a slight positive buoyancy.

Power Requirements: 440 V, 60 Hz/380 V, 50 Hz KVA seven, hydraulically-powered.

Propulsion: 6 KW thrusters provide maneuvering in all translational and rotational motions. Automatic control of depth, altitude, pitch and roll.

Instrumentation: Two CCTV (one fixed and one on pan/tilt device). Tool rack with tools sample basket, stereo-camera system. Three manipulators: one master-slave primary work unit; two rate controlled, work-assistance grabbers. Echo-sounder. Two directional hydrophones. Transponder. Depthometer.

Navigation: Automatic tracking from surface provides position reference accuracy of ± 1 percent.

Shipboard Components: Control/display console and computer, master transformer, umbilical cable and container, launch/retrieval equipment.

Support Ship Requirements: Deck space of 50 to 80m² (538 to 861 ft²)

Operating Maintenance Crew:

Total Shipping Volume:

Total Shipping Weight: 10.9t (12 tons) not including launch/retrieval device.

Status: Operational

Builder: Saab-Scania

Aerospace Division

Linkoping, Sweden

Operator/Point-of-Contact: Oceaneering International

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